02 00 00 GENERAL PROVISIONS

1. Sustainable Design:

   A. The University promotes energy-efficient green design, construction, and building operations.

   B. Whenever possible, materials are to be selected and specified following the United States Green Building Council's LEED (Leadership in Energy and Environmental Design) Green Building Rating System®.

02 06 00 SCHEDULES FOR EXISTING CONDITIONS

1. Coordinate schedules for subsurface investigations, site remediation, underground storage tank removal, facility remediation, and/or hazardous waste drum handling with the UT Health EHS Department, through the UT Health Project Manager.

02 26 00 HAZARDOUS MATERIAL ASSESSMENT

1. Coordinate Hazardous Material Assessment requirements with the UT Health EHS Department, through the UT Project Manager.

02 82 00 REMOVAL OF FRIABLE ASBESTOS-CONTAINING MATERIALS – SEE SPEC. SECTION

02 82 00A REMOVAL OF NON-FRIABLE ASBESTOS-CONTAINING MATERIALS – SEE SPEC. SECTION

02 84 16 REMOVAL OF FLUORESCENT LIGHT BALLASTS, CAPACITORS, AND FLUORESCENT LIGHT TUBES – SEE SPEC. SECTION

02 85 00 MOLD REMEDIATION – SEE SPEC. SECTION

02 42 00 REMOVAL AND SALVAGE OF CONSTRUCTION MATERIALS

1. Coordinate with the UT Health Project Manager to maintain items that appear to represent value. The following list describes some, but not necessarily all such items:

   - Cabinets, lockers, etc.
   - Doors
   - Furniture
   - Hardware
   - Signage and lettering

SECTION 02 82 00 00 - REMOVAL OF FRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for the removal of friable asbestos-containing materials. Products shall be as follow or as approved by the UT Health consultant. Installation procedures shall be by the product manufacturer's recommendations. Demolition and removal of materials shall be required to support the work.

B. Description
  1. Furnish all labor, materials, facilities, equipment, services, employee training, and testing, permits, and agreements necessary to perform the work required for asbestos removal, encapsulation, repair, clean-up, decontamination, re-insulation, and all other work by these specifications, in accordance with the regulations from the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the recommendations of National Institute of Occupational Safety and Health (NIOSH), and any other applicable federal, state and local government regulations. Whenever there is a conflict or overlap of the above references, the most stringent provision is applicable.
  2. The work specified herein shall be performed by competent persons trained, knowledgeable and qualified in the state-of-the-art techniques of asbestos abatement, handling, and subsequent cleaning of contaminated areas.

C. Scope
  1. The quantities of materials and limits of abatement work area(s) shall be verified by the asbestos contractor.

D. Asbestos Hazard
  1. Asbestos-containing material when damaged or disturbed is subject to fiber releases. Wet methods are a primary means of controlling fiber release.
  2. Strict compliance with each of the provisions outlined in these specifications for the encapsulation, repair, and handling of asbestos-containing material is of great importance, because:
    a. The inhalation of airborne asbestos fibers can cause very serious and often fatal diseases.
    b. Workers may not be aware they are inhaling asbestos fibers.
    c. Symptoms of the disease do not appear for many years.
    d. Only the Contractor and his employees can prevent the inhalation of asbestos fibers, which can lead to the development of asbestos-related disease.
    e. No insurance is available to provide for asbestos-related diseases.

E. Other Hazardous Material
  1. Contractor shall comply with OSHA 29 CFR 1926.62 - Lead in Construction when demolishing any equipment or architectural component identified as lead-containing or lead-based paint. The work of this project is considered a demolition activity.
  2. UT Health anticipates that a substantial amount of the Project will involve lead paint.

F. Qualifications
  1. UT Health and UT Health's Representative will verify and approve the experience of the Asbestos Abatement Contractor based upon submission at the time of bidding by the Contractor evidence of the following:
    a. Experience: Provide the names and locations of at least three asbestos abatement projects of comparable size and complexity comparable with this work. Provide the names and telephone numbers of the contact person at previous projects. Provide the final air monitoring decontamination fiber levels achieved.

   b. Personnel: Provide the name(s) of "Competent Person" as defined by OSHA 29 CFR 1926.32(f) - Asbestos. Demonstrate education and specialized training with successful completion of the examination of an EPA-approved course. Provide evidence of participation in five projects of complexity comparable to this project.
   c. Licensing and Certification: The Contractor must hold a current, valid asbestos license issued by the State in which the work is to be performed.

G. Notices And Record Keeping
1. Contractor shall maintain for at least 30 years, a record for each asbestos project in which the Contractor engages. Each record shall include the following information: name, address, and social security number of all personnel involved with the project, the name address, and social security number of the OSHA "Competent Person" who will supervise the work, the amount of asbestos material that was removed, repaired, encapsulated or disturbed, the commencement and completion date of the work, copies of Hazardous Waste Manifest(s), personal air monitoring results and any other appropriate information.
2. The Contractor shall send written notification as required by USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61, Subpart M) to the UT Health consultant, at least 10 working days before beginning any work on asbestos-containing materials.
3. Include the following information:
   a. Name and address of Owner or operator.
   b. Description of the facility being demolished or renovated, including the size, age, and prior use of the facility.
   c. Estimate of the approximate amount of asbestos material present in the facility in terms of linear feet of pipe, and surface area on other facility components. For facilities in which the amount of asbestos materials is less than 80 linear meters (260 linear feet) on pipes and less than 15 square meters (160 square feet) on other facility components, explain techniques of estimation.
   d. Location of the facility being demolished or renovated.
   e. Scheduled starting and completion dates of demolition or renovation.
   f. Nature of planned demolition or renovation and method(s) to be used.
   g. Procedures to be used to comply with the requirements of USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61 Subpart M).
   h. Name and location of the waste disposal site where the asbestos waste material will be deposited.
4. Before to the commencement of work, the Contractor shall submit the following documents to UT Health's Representative. No work will be allowed to start until these documents have been approved:
   a. The schedule of the work, including manpower, length, and number of work shifts. The schedule shall be coordinated with UT Health's full occupancy of all areas of the building.
   b. Satisfactory proof that written notification has been provided to the EPA regional office and UT Health.
   c. Proof that all required permits, disposal site locations, and arrangements for transportation and disposal of asbestos-contaminated materials, supplies, and the like have been obtained.
   d. Complete a worker certificate indicating that all employees have had instruction and training on the hazards of asbestos exposure, the use, and fitting of respirators, protective dress, wet and dry decontamination procedures, entry and exit from work areas, and all aspects of work procedures and protective measures.
   e. Documentation indicating that all employees have received appropriate medical examinations and have successfully passed fit testing for the respirator to be worn. As a minimum, medical exams must be consistent with OSHA 29 CFR 1926.1101(K)(9)(viii)(G)-Asbestos Regulation.

- f. Samples of signs to be used in and around the work area to comply with 0SHA 29 CFR 1926.1101(K)(9)(viii)(I)- Asbestos regulations and as required by federal, state, and municipal regulations.
- g. Safety Data Sheets (SDS) for all chemicals used during work performed under this section.
- h. Encapsulation data and encapsulation procedures.
- i. Design of pressure differential system including calculation used to arrive at the number of machines necessary to achieve one air change every 10 minutes.
- j. Location of personnel and material decontamination units for each work area.

5. Contractor shall provide written notification to UT Health's Representative of his intent to start work at least five days in advance. In no case will the Contractor start work until authorization to proceed is given.
6. During the work, the Contractor shall maintain a daily log which will be kept at the job site. Items to be included in the daily log shall include but are not limited to the following:
   - a. Meetings, purpose, attendees, discussions, items of resolution.
   - b. Visitations, authorized and unauthorized.
   - c. Sign-in sheets of all personnel entering and leaving the work area.
   - d. Special or unusual events (i.e., barrier breaching equipment failures).
   - e. Personal air monitoring results.
   - f. Two copies of the daily log are required for Project Closeout.

H. Terminology (Definitions)

1. Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, enclosure, or encapsulation.
2. Air Lock - A system for permitting ingress or egress without permitting air movement between any two adjacent areas consisting of two curtained doorways. The airlock must be maintained in an uncontaminated condition at all times.
3. Air Monitoring; - The process of measuring the asbestos fiber content of a specific volume of air in a stated period using methods approved or recommended by OSHA, EPA, NIOSH, or other methods endorsed by UT Health or UT Health's Representative.
4. Amended water - Water to which a surfactant has been added.
5. Asbestos - A generic name given to several naturally occurring hydrated mineral silicates that possess a unique crystalline structure, are incombustible in air, and are separable into fibers. Asbestos includes the asbestiform varieties of Chrysotile (serpentine), Crocidolite (Riebeckite), Amosite (Cummingtonite-Grunente), Anthophyllite, Actinolite, and Tremolite.
6. Asbestos-containing. material (ACM) - Any material that contains more than 1 percent asbestos by weight as determined by Polarized Light Microscopy (PLM).
7. Authorized Visitor - UT Health or his designated representative, or a representative of any regulatory or other agency having jurisdiction over the project.
8. Class I - Asbestos work means activities involving the removal of thermal systems insulation (TSI) and surfacing ACM and PACM.
9. Class II - Asbestos work means activities involving the removal of ACM which is not TSI or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.
10. Class III - Asbestos work means repair and maintenance operations where "ACM" including TSI and surfacing ACM and PACM is likely to be disturbed.
11. Class IV - Asbestos work means maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean up dust, waste, and debris resulting from Class I, I,II, and III activities.
12. Critical Barrier - A unit of temporary construction that provides the only separation between an asbestos work area and an adjacent, potentially occupied, space. The critical barrier is composed of at least one intact sheet of polyethylene sheeting.
13. Decontamination Enclosure System - A series of connected rooms with curtained doorways between any two adjacent rooms, for the decontamination of workers or materials and equipment. A decontamination system contains at least two airlocks.

14. Disposal - All procedures necessary to transport and deposit the asbestos-contaminated material stripped and removed from the building in a waste disposal site in compliance with applicable federal, state, and local regulations.
15. Disposal Site - A site approved by the EPA for the disposal of asbestos-containing wastes.
16. Encapsulant - A liquid that can be applied to asbestos-containing materials and which controls the possible release of fibers from the materials.
17. Encapsulation - The use of an agent to seal the surface (bridging encapsulant) or penetrate the bulk (penetrating encapsulant) of the asbestos-containing material.
18. HEPA -High-Efficiency Particulate Air - A type of filter which is 99.97% efficient at filtering particles of 0.3 micrometers in diameter.
19. HEPA Vacuum Equipment - Vacuuming equipment equipped with a HEPA filter in the exhaust outlet, and so designed and maintained that 99.97% of all particles of 0.3 micrometers in diameter in the inlet air are collected and retained.
20. Negative Pressure Respirators - Respirators that function by the wearer breathing in air through a filter.
21. NIOSH - National Institute of Occupational Safety and Health.
22. Owner's Representative - Authorized Consultants
23. Permissible Exposure Level (PEL) - A level of airborne fibers specified by OSHA as an occupational exposure standard for asbestos. It is 0.1 f/cc of air, eight-hour TWA, as measured by Phase Contrast Microscopy.
24. Repair - The restoration of damaged or deteriorated asbestos-containing material to intact condition.
25. Respirator Protection Program - A set of procedures and equipment required by OSHA if employees wear negative pressure respirators or if fiber levels are above the PEL.
26. Surfactant - Chemical wetting agent added to water to improve penetration, thus reducing the amount of water required for a given operation or area, and enhancing the effect of the water in reducing fiber release.
27. Thermal Systems Insulation - Material applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain, water condensation, or for other purposes.
28. Wet Cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths and mops or other cleaning tools that have been dampened with clean water and afterward disposing of these cleaning tools as asbestos-contaminated waste.

I. Permits And Licenses:
   1. The Contractor must maintain current licenses as required by applicable state or local jurisdictions for the removal, transporting, disposal, or other regulated activity relative to the work of this contract.

J. Regulations
   1. This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specifications. This section also sets forth those notices and permits which are known to UT Health and which either must be applied for and received or which must be given to governmental agencies before the start of work.
   2. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.
   3. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations about work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state, and local regulations. The Contractor shall hold UT Health and UT Health's Representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of himself, his employees, or his Sub-Contractors.

4. Federal requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following regulations:
    a. U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:
        1) U.S. Department of Labor, OSHA, including, but not limited to:
            a) Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite; Final Rules
               Title 29, Part 1910, Section 1001
               Part 1926, Section 1101 of the Code of Federal Regulations
            b) Respiratory Protection
               Title 29, Part 1910, Section 134 of the Code of Federal Regulations
            c) Construction Industry
               Title 29, Part 1926.1011, of the Code of Federal Regulation
            d) Access to Employee Exposure and Medical Records
               Title 29, Part 1910, Section 2 of the Code of Federal Regulations
            e) Hazard Communication
               Title 29, Part 1910, Section 1200 of the Code of Federal Regulations
            f) Specifications for Accident Prevention Signs and Tags
               Title 29, Part 1910, Section 145 of the Code of Federal Regulations
        2) U.S. Environmental Protection Agency (EPA) including, but not limited to:
            a) Asbestos Abatement Projects Rule
               40 CFR Part 762
               CPTS 62044, FRL 2843-9
               Federal Register, Vol. 50 No. 134, July 12, 1985
               P28530-28540
            b) Regulation for Asbestos
               Title 40, Part 61, Subpart A of the Code of Federal Regulations
            c) National Emission Standard for Asbestos
               Title 40, Part 61, Subpart M (Revised Subpart B) of the Code of Federal Regulations
        3) State requirements that govern asbestos abatement work and/or hauling and disposal of asbestos waste materials.
        4) Contractor shall abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials including the following:
            a) American National Standards Institute (ANSI)
               1430 Broadway
               New York, NY 10018
               (212) 354-3300
            b) Fundamentals Governing the Design and Operation of Local Exhaust Systems Publication Z9.2-79
            c) Practices for Respiratory Protection Publication Z288.2-80
            d) American Society for Testing and Materials (ASTM)
               1916 Race Street
               Philadelphia, PA 19103
               (215) 299-5400
            e) Specification for Encapsulants for Friable Asbestos-Containing Building Materials
            f) Safety and Health Requirements Relating to Occupational Exposure to Asbestos

K. Owner's Representative
    1. UT Health's Representative is authorized by UT Health to perform the following:
        a. Have free access to all asbestos work areas.
        b. To assist in the interpretation of procedures.
        c. To advise on all provisions of the contract documents about the control of asbestos.

  d. To stop work if, in the course of performing their monitoring duties, an instance of substantial non-conformance with the contract documents is observed.
  e. To stop work if a situation presenting a health hazard to workers or UT Health's employees or occupants of the building is observed.
  f. To act as UT Health's liaison in technical matters involving asbestos-related work.
  g. To perform air sampling inside and outside the asbestos work area during the project. The Contractor shall cooperate fully with the Owner's Representative, its agents and employees, and the sure cooperation of his/her workers during the collection of air samples and work area inspections.
  h. UT Health's Representative role in advising UT Health on environmental health matters does not relieve the Contractor's obligation to comply with all applicable health and safety regulations. Air monitoring results generated by the Owner's Representative shall not be used by the Contractor to represent compliance with regulatory agency requirements for the monitoring of worker's exposure to airborne asbestos, nor shall any other activity on the part of the Owner's Representative represent the Contractor's compliance with applicable health and safety regulations.

L. Pre-Construction Conference
  1. An initial progress meeting recognized as "Pre-Construction Conference" shall be held prior to the start of any work. The contractor shall meet at the project site, with General Superintendent, The University, The University's Representative, and other entities concerned with asbestos abatement work. Record discussions and agreements and furnish a copy to each participant. Provide at least 72 hours advance notice to all participants prior to convening Pre-Construction Conference.
  2. This is an organizational meeting, to review responsibilities and personnel assignments, to locate the containment and decontamination areas; and temporary facilities including power, light, water, etc.
  3. Submit waivers on forms, and executed them in a manner acceptable to UT Health. Administrative requirements that must proceed or coincide the with Contractor's submittal for final payment shall consist of the following:
    a. Completion of project closeout requirements.
    b. Completion of items specified for completion beyond the time of substantial completion (regardless of whether special payment application was previously made).
    c. Assurance, satisfactory to UT Health, that unsettled claims will be settled and that work not completed and accepted will be completed without undue delay.
    d. Transmittal of required project construction records to UT Health.
    e. Landfill receipts for all asbestos-containing material.
    f. Proof, satisfactory to UT Health, that taxes, fees, and similar obligations of Contractor have been paid.
    g. Removal of temporary facilities, services, surplus materials, rubbish, and similar elements.
    h. Consent of surety for final payment.

M. Project Closeout
  1. Project closeout is the term used to describe certain collective project requirements that indicate completion of the work to be fulfilled near the end of the contract time. Also, in preparation for final acceptance of the work by UT Health, as well as, final payment to the Contractor and the normal termination of the Contract.
  2. Include supporting documentation for completion as indicated in these contract documents.
  3. Submit a statement on accounting of changes to the Contract Sum.
  4. Advise UT Health of pending insurance change-over requirements.
  5. Submit specific warranties, workmanship and maintenance bonds, maintenance agreements, final certifications, and similar documents.
  6. Obtain and submit releases enabling UT Health's full, unrestricted use of the work area and access to services and utilities. Where required, include occupancy permits, operating certificates, and similar releases.
  7. Results of the completed inspection will form the initial "punch list" for final acceptance.

8. A complete record, certified by the testing laboratory, of all personal air monitoring results.
9. Complete the following cleaning operations as outlined in Paragraph “Decontamination Procedures” before requesting UT Health's Representative inspection for certification of substantial completion.
    a. Remove exposed labels in finished spaces which are not required as permanent labels on materials supplied as part of the work, except for "Asbestos", "Asbestos Free", or Thermal Insulation Labels specified elsewhere.
    b. Clean transparent materials, affected by the work including mirrors and window/door glass, to a polished condition, removing substances that are noticeably vision-obscuring materials. Replace broken glass and damaged transparent materials.
    c. Clean exposed hard-surfaced finishes affected by the work, to a dirt-free condition, free of dust, stains, films, and similar distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to their original reflective condition.
    d. Clean plumbing fixtures affected by the work to a sanitary condition, free of stains including those resulting from water exposure.
    e. Replace all HVAC filters using materials supplied by UT Health or clean non-replaceable filters after a minimum of two days of operation of HVAC equipment.
    f. Clean light fixtures and lamps, which have been affected by the work to function with full efficiency. Replace lamps where inoperable.
    g. Repair any damage to wall, ceiling, and floor surfaces caused by the installation and removal of the polyethylene sheeting.

N. Personnel Protection
1. Prior to the commencement of work, the workers shall be instructed and be knowledgeable in the areas described in Paragraph "Submittals and Notices" having to do with employees.
2. Worker Protection - shall comply with 29 CFR 1910.134 (Respiratory Protection).
    a. Because there is no known safe level of asbestos exposure, it is prudent to reduce worker's exposures to as low a level as possible. Proper respiratory protection is critical in minimizing exposure.
    b. Workers shall be provided, as a minimum, with personally issued and marked respirators equipped with high-efficiency particulate filters approved by NIOSH to be worn in the designated work area and/or whenever a potential asbestos exposure exists. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
    c. No worker shall be exposed to levels greater than 0.01 f/cc as determined by the protection factor of the respirator worn and the work area fiber levels.
    d. Whenever powered purifying respirator protection is used, a sufficient supply of replacement batteries and HEPA filter cartridges shall be provided to the workers.
    e. Air monitoring required by OSHA is the work of the Contractor and is not covered in this specification. The contractor shall post, on a daily basis, results of the air monitoring results from the previous shift. A complete record, certified by the testing laboratory, of all personal air monitoring tests and results will be furnished to The University and The University's Representative prior to the Contractor's Request for Final Payment.
    f. During encapsulation operations or usage of other organic base aerosols (e.g., spray glue, expanding foam), workers shall be provided with combination cartridges consisting of organic vapor and HEPA sections.
    g. Workers shall be provided with sufficient sets of protective full-body clothing to be worn in the designated work area and/or whenever potential asbestos exposure exists. Such clothing shall include, but not be limited to, full-body coveralls, headgear, and gloves. Workers shall assure that hoods covering their hair are worn in the designated work areas at all times. Eye protection and hard hats shall be provided as required by applicable safety regulations. Eye protection shall be worn during encapsulation operations. Non-disposable type protective clothing and footwear shall be left in the work area until the end of the asbestos abatement work, at which time such items will be disposed of as asbestos waste.

  - h. Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent body contamination.
  - i. Protective clothing shall not be worn instead of street clothing outside the work area.
  - j. Visitor Clothing: The Contractor shall provide authorized visitors with a suitable respirator, protective clothing, headgear, eye protection, and footwear as described herein, whenever they enter the work area.
- 3. Decontamination and Work Procedures: The decontamination and work procedures to be followed by workers shall be posted as described in these specifications.
- 4. Worker and Authorized Visitor Protection Procedures:
  - a. Each worker and authorized visitor shall, upon entering the job site, remove street clothes in a designated clean change area and put on a respirator with new filters and clean protective clothing before entering the work area.
  - b. The Contractor's employees shall perform a positive/negative respirator fit test each time he enters the work area. If leakage occurs, the respirator must be re-adjusted or replaced.
  - c. Workers shall maintain their respirators in a safe operating condition. The condition of respirators shall be checked daily.
  - d. Workers and visitors shall complete the decontamination procedures as outlined in the specification upon exiting the work area.
  - e. Workers shall not eat, drink, smoke, or chew gum or tobacco in or near the asbestos work areas.
  - f. Workers shall be fully protected with respirators and protective clothing immediately before the first disturbance of asbestos-containing or contaminated materials and until final cleanup is completed.

O. Air Monitoring

- 1. The airborne fiber counts outside the work area will be monitored to detect faults in the work area isolation such as contamination of the building outside of the work areas with airborne asbestos fibers, failure of filtration, or rupture in the negative pressure system.
  Should any of the above occur, the Contractor shall immediately cease asbestos abatement activities until the fault is corrected. Work shall not recommence until authorized by the Owner's Representative. In the case of mini-enclosures, UT Health's Representative will monitor the air in a remote location of the residence to determine the baseline of asbestos.
- 2. The airborne fiber counts in the work area will be monitored. The purpose of this air monitoring will be to detect airborne fiber counts which may significantly challenge the ability of the work area isolation procedures to protect the balance of the building or outside of the building from contamination by airborne fibers. In the case of mini-enclosures UT Health's representative may monitor air outside of several enclosures if they are nearby.
- 3. Contractor shall maintain an average airborne count inside the work area of less than 0.5 f/cc. If the fiber counts rise above this figure for any sample taken, revise work procedures to lower fiber counts. If the TWA fiber count for any work shift or eight-hour period exceeds 0.5 f/cc, stop all work, leave the pressure differential system in operation and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.
- 4. If airborne fiber counts exceed 1.0 f/cc for any period of time cease all work until fiber counts fall below 0.5 f/cc and notify the Owner's Representative. Do not recommence work until authorized in writing by UT Health Project Manager.
- 5. If any air sample taken outside of the work area exceeds the 0.01 f/cc of air, the Contractor shall immediately and automatically stop all work. If this air sample was taken inside the building and outside of critical barriers around the work area, immediately erect new critical barriers to isolate the affected area from the balance of the building. Erect Critical Barriers at the next existing structural isolation of the involved space (e.g., wall, ceiling, and floor). Leave Critical Barriers in place until completion of work and insure that the operation of the negative pressure system in the work area results in a flow of air from the balance of the building into the affected area.
- 6. If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a temporary decontamination facility consisting of a shower room and changing room. After cleaning and decontamination of the affected area remove the shower room and leave the changing room in place as an airlock.

7. After certification of visual inspection in the work area, remove critical barriers separating the work area from the affected area. Final air samples will be taken within the entire area.
8. The following procedure will be used to resolve any disputes regarding fiber types when a project has been stopped due to excessive airborne fiber counts. "Airborne Fibers" referred to above include all fibers regardless of composition as counted in the Phase Contrast Microscopy (PCM) NIOSH 7400 Method procedures. If work has stopped due to high airborne fiber counts, air samples will be secured in the same area by The University's Representative for analysis by electron microscopy. "Airborne fibers” counted in samples analyzed by Scanning or Transmission Electron Microscopy (TEM) shall be only asbestos fibers, but of any diameter and length. Subsequent to analysis by Electron Microscopy the number of airborne fibers shall be determined by multiplying the number of fibers, regardless of composition, counted by the PCM NIOSH 7400 Method procedure by a number equal to asbestos fibers counted divided by all fibers counted in the electron microscopy analysis.
9. If electron microscopy is used to arrive at the basis for determining airborne fiber counts by the above paragraph, and if the average of airborne asbestos fibers in all samples taken exceeds 0.1 f/cc, or if any one sample exceeds 0.2 f/cc, then the cost of such analysis will be born by the Contractor, at no additional cost to UT Health.
10. UT Health's Representative will secure at least the following air samples to establish a baseline before the tart of work involving large enclosures:

Location Sampled	**Number of Samples**	**Analysis Method**	**Detection Limit f/cc**	**Minimum Volume Liters**	**Rate LPM**
Each Work Area	1	PCM	0.01	1,900	2-16
Outside Each Work Area	1-3	PCM	0.01	1,900	2-16

11. Base Line is an action level expressed in f/cc, which is ten percent greater than the largest of the following:
    a. Average of the samples collected on cellulose ester filters outside each work area.
    b. Average of the samples collected on cellulose ester filters outside the building.
    c. 0.01 fibers per cubic centimeter.
12. Daily: From the start the work of Paragraph "Temporary Enclosure" through the work of Paragraph "Project Decontamination," UT Health may be taking the following samples on a daily basis. The location of each air sample will be determined by UT Health's Representative.
    a. Baseline
    b. Work Area
13. For larger enclosures samples will be collected on 25 mm cassettes with the following filter medial:
    PCM: 0.8 micrometers mixed cellulose ester.

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM
Each Work Area	2	PCM	0.01	1,900 as required by conditions	2-16
Outside Each Work Area Critical Barrier	1	PCM	0.01	1,900	2-16
Clean Room	1	PCM	0.01	1,900	2-16
Equip Decon	1	PCM	0.01	1,900	2-16

14. Additional samples may be taken at UT Health or UT Health's Representative discretion. If airborne fiber counts exceed allowed limits, additional samples will be taken as necessary to monitor fiber levels.
15. The services of a testing laboratory will be employed by UT Health to perform laboratory analysis of the air samples. Samples will be sent daily so that verbal reports on air samples can be

obtained promptly. A complete record, certified by the testing laboratory, of all air monitoring tests and results will be furnished to UT Health's Representative, and the Contractor.

16. Air samples may be analyzed on-site by UT Health's Representative if they are to be analyzed by the NIOSH 7400 Method.
17. Cellulose ester filters will be analyzed using the PCM NIOSH 7400 Method. This analysis will be carried out at a laboratory located off the job site.
18. At the completion of the work in occupied areas and prior to the dismantling of the isolation system, final air clearance will be conducted by the Owner's Representative.
19. Decontamination of the work area will be considered complete when all samples indicate fiber levels are less than 0.0l f/cc of air as analyzed by PCM NIOSH 7400 Method or an average of fewer than 70 structures per square millimeter of filter area as analyzed by TEM; Level II AHERA Method.
20. The Contractor may conduct his air monitoring and laboratory testing. If he elects to do this the cost of such air monitoring and laboratory testing shall be included in the Contract Sum.

P. Equipment Removal Procedures

1. Clean all external surfaces of contaminated waste containers and equipment thoroughly by wet sponging or HEPA vacuuming before moving such items into the equipment decontamination enclosure system washroom for final cleaning and removal to uncontaminated areas. Ensure that personnel does not leave the work areas through the equipment decontamination enclosure system.

Q. Disposal Activities

1. It is the responsibility of the Contractor to comply with current federal, state, and local regulations concerning the waste handling, transportation, and disposal of asbestos-containing material (ACM) and accompanying solvents or residues.
2. The Contractor will document the actual disposal of the waste at the designated landfill by completing a Disposal Certificate or submitting proof of landfill receipt.

1.2 PRODUCTS

A. Materials

1. All Contractor's equipment delivered to the site shall be free of asbestos contamination.
2. Store all materials subject to damage off the ground, away from wet surfaces, and under cover sufficient to prevent damage or contamination.
3. Damaged or deteriorating materials shall not be used and shall be removed from the premises. Materials that become contaminated shall be disposed of by applicable regulations.
4. Polyethylene flame retardant sheet of 6-mil thickness shall be used unless otherwise specified. Polyethylene sheeting shall be sized to minimize the frequency of joints. Polyethylene sheeting must satisfy the National Fire Prevention Association Standard 701, "Small Scale Fire Test for Flame Resistant Textile and Film."
5. Adhesive tape shall be capable of sealing joints of adjacent sheets of polyethylene and for use in attachment of polyethylene sheets to finished or unfinished surfaces of similar materials and shall be capable of adhering under dry and wet conditions, including the use of amended water. Contractor shall use adhesive tape compatible with finished surfaces.
6. Protective devices such as, but not limited to, disposable clothing, respirators, gloves, hard hats, etc. shall be used.
7. Wetting agent shall be a mixture of 50/50 polyoxyethylene ether and polyglycol ester or equivalent commercial product.
8. Encapsulant materials shall be the bridging and penetrating type and conform with the following characteristics:
   a. Encapsulants shall not be solvent-based or utilize a hydrocarbon in the liquid in which the solid parts of the encapsulant are suspended.
   b. Encapsulant shall not be flammable.

9. A non-hardening lagging sealer for enclosing and sealing raw exposed edges and surfaces of asbestos-containing materials.
10. Pre-mixed or job-mixed insulating plaster manufactured for use on plumbing equipment shall be used when repairing damaged thermal insulation material.
11. Non-woven fibrous glass mat and open weave glass fiber mat cloth for the repair of thermal systems insulation.
12. Fire retardant sealant shall prevent fire, smoke, water and toxic fumes from penetrating through sealants. Sealant shall have a flame spread, smoke and fuel contribution of zero, and shall be ASTM and Underwriter's Laboratory (UL) rated for three hours for standard method of fire test for fire stop systems

B. Tools And Equipment
1. Provide suitable tools for the repair and encapsulation of asbestos-containing materials and for the removal of asbestos-containing materials that are beyond repair. Wire brushes shall not be used as a means of removing or cleaning asbestos-containing materials from surfaces, if they are used as the surface is being sprayed with water or amended water.
2. Provide a sufficient number of HEPA-filtered vacuum cleaners equipped with pick-up adapters, steel floor wands, crevice tools, and carpet tools.
3. Airless sprayers capable of spraying amended water shall be provided in sufficient number to allow continuous uninterrupted work.
4. Asbestos filtration devices shall utilize high-efficiency particulate air (HEPA) filtration systems.
5. Transportation equipment, as required, shall be suitable for loading, temporary storage, and unloading of contaminated waste without exposure to persons or property, and shall be quiet in motion if used within the building.

1.3 EXECUTION

A. Safety Procedures For Power And Lighting
1. The use of wet methods for removal, repair, encapsulation or cleaning procedures increases the potential for electrical shock when working around electrical panels, conduits, light fixtures, alarm systems, junction boxes, transformers, etc. In coordination with UT Health, de-energize as much electrical equipment as possible to prevent electrical shock to employees performing the work. The Contractor shall use the following precautions:
    a. Use non-conductive tools and vacuum attachments.
    b. Utilize "hot line" covers over energized cables and power lines when possible.
    c. Ensure all electrical equipment in use is properly grounded before the job starts. Check outlets, wiring, extension cords and power pickups.
    d. Avoid stringing wiring across floors. Elevate wiring if possible.
    e. Ensure electrical outlets are tightly sealed and taped to avoid water spray.
    f. Determine operating voltages of equipment and lines before working on or near energized parts.
    g. Energized parts must be insulated or guarded against employee contact and other conductive objects. Extension cords must be three-wire type and connected to a Ground Fault Interrupter (GFI) circuit.
    h. Lock or secure de-energized circuits at the panel and post warning signs.
    i. Seal heating vents with two layers of polyethylene sheeting prior to the start of work. The Contractor shall repair any damage caused by the Contractor's operations to ductwork, grilles, dampers, louvers, or HVAC equipment at the completion of the work at the Contractor's expense. Coordinate all lockout and or de-energizing with the Owner.
2.

B. Temporary Facilities
1. Use qualified tradesmen for the installation of temporary services and facilities. Locate temporary services and facilities where they will serve the entire project adequately and result in minimum

interference with the performance of the work and operations of the building. Coordinate all installations and shut downs with the building owner.

2. Relocate, modify, and extend services and facilities as required during the course of work so as to accommodate the entire work of the project.
3. Provide new or used materials and equipment that are undamaged and in serviceable condition. Provide only materials and equipment that are recognized as being suitable for the intended use, by compliance with appropriate standards.
4. During the erection and/or moving of scaffolding, care must be exercised so that the polyethylene floor covering is not damaged.
5. Clean, as necessary, debris from non-slip surfaces.
6. After of abatement work, clean all construction aids within the work area, wrap in one layer of 6-mil polyethylene sheet, and seal before removal from the work area.
7. Temporary water service connections to UT Health's water system shall include backflow protection. Valves shall be temperature and pressure rated for the operation of the temperatures and pressures encountered.
8. Employ heavy-duty abrasion-resistant hoses with a pressure rating 50 percent greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit. Provide fittings as required to allow for connection to existing wall hydrants or spouts, as well as temporary water heating equipment, branch piping, showers, shut-off nozzles, and equipment.
9. Electrical Services shall comply with applicable NEMA, NECA, and UL standards and governing regulations for materials and layout of temporary electric service.
10. Provide a weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity, and power characteristics to accommodate the performance of work during the construction period. Install temporary lighting adequate to provide sufficient illumination for safe work and traffic conditions in every area of work.
11. Provide receptacle outlets equipped with ground fault circuit interrupters, reset buttons and pilot lights, for plug-in connection of power tools and equipment.
12. Use only grounded extension cords; use "hard-service" cords were exposed to abrasion and traffic. Use single lengths or use waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas of work. All cords shall be elevated off the floor inside the containment area.
13. Temporary wiring in the work area shall be type UL non-metallic sheathed cable located overhead and exposed for surveillance. Do not wire temporary lighting with plain, exposed (insulated) electrical conductors. Provide liquid tight enclosures or boxes for wiring devices.
14. Provide Type "A" fire extinguishers for temporary offices and similar spaces where there is minimal danger of electrical or grease-oil-flammable liquid fires. In other locations provide type "ABC" dry chemical extinguishers, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.
15. Use of UT Health's existing toilet facilities, as indicated, will be permitted, so long as these facilities are properly cleaned and maintained in a condition acceptable to UT Health. At substantial completion, restore these facilities to the condition prevalent at the time of initial use. All provisions of these specifications regarding leaving the work area must be met.
16. When mini-enclosures area being used all of the requirements above will be enforced by UT Health's Representative. The construction and set-up of the mini-enclosures may be done by the Abatement Contractor.

C. Pressure Differential System
   1. Before the start of work Contractor shall submit design of pressure differential system to The University's Representative for review. Do not begin work until system has been approved by Owner's Representative. Include in the submittal the following:
      a. Number of pressure differential machines required and the calculations necessary to determine the number of machines.
      b. Description of projected air-flow within work area and methods required to provide adequate air flow in all portions of the work area.

2. If the enclosure is not a mini-enclosure, the Contractor must supply the required number of asbestos air filtration units to the site in accordance with these specifications. Each unit shall include the following:
   a. Cabinet constructed of steel or other durable materials able to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Cabinet shall be factory sealed to prevent asbestos-containing dust from being released during use, transport, or maintenance. Access to and replacement of all air filters shall be from intake end. Unit shall be mounted on casters or wheels.
   b. Rate capacity of fan according to useable air-moving capacity under actual operating conditions. Use centrifugal-type fan.
   c. The final filter shall be the HEPA type. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame.
   d. A continuous rubber gasket shall be located between the filter and the filter housing to form a tight seal.
   e. Provide HEPA Units that are individually tested and certified on site by an independent testing agency to have an efficiency of not less than 99.97 percent when challenged with 0.3 m dioctylphthlaate (DOP) particles when tested in accordance with Military Standard Number 2182 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions.
   f. Pre-filters, which protect the final filter by removing the larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. The first-stage pre-filter shall be a low-efficiency type (e.g., for particles 10 microns and larger). The second-stage (or intermediate) filter shall have a medium efficiency (e.g., effective for particles down to 5 microns). Pre-filters and intermediate filters shall be installed either on or in the intake grid of the unit and held in place with special housings or clamps.
   g. Each unit shall be equipped with a Magnahelic gauge or manometer to measure the pressure drop across filters and indicate when filters have become loaded and need to be changed. A table indicating the useable air-handling capacity for various static pressure readings on the Magnahelic gauge shall be affixed near the gauge for reference, or the Magnahelic reading indicating at what point the filters should be changed, noting Cubic Feet per Minute (CFM) air delivery at that point. Provide units equipped with an elapsed time meter to show the total accumulated hours of operation.
   h. The unit shall have an electrical (or mechanical) lockout to prevent fan from operating without a HEPA filter. Units shall be equipped with automatic shutdown system to stop fan in the event of a major rupture in the HEPA filter or blocked air discharge. Warning lights are required to indicate normal operation, too high a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge).
   i. Electrical components shall be approved by the National Electrical Manufacturers Association (NEMA) and Underwriters' Laboratories (UL). Each unit shall be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet shall be grounded.
   j. If a mini-enclosure is used the air filtration unit may be a HEPA filtered vacuum with a flow rate of at least 100 cubic feet per minute (CFM).
3. Provide a fully operational pressure differential system within the work area maintaining continuously a pressure differential across work area enclosures of 0.02 inches of water for glove bag operations and mini-containments**.** Demonstrate to The University's Representative the pressure differential by use of pressure differential meter or a manometer, before disturbance of any asbestos-containing materials. In the case of a mini-enclosure visual evidence of pressure differential through the use of a smoke generation tube shall be sufficient as in paragraph C.13 of this section.
4. Continuously monitor and record the pressure differential between the work area and the building outside of the work area.
5. Provide fully operational negative pressure systems supplying a minimum of one air change every ten minutes (six changes per hour), less in the instance of a mini-enclosure. Determine the

volume in cubic feet of the work area by multiplying floor area by ceiling height. Determine total ventilation requirement in cubic feet per minute (cfm) for the work area by dividing this volume by the air change rate.

6. Ventilation Required (CFM) = Volume of work area (cu. ft.)/10 min.
7. Determine number of units needed to achieve ten-minute change rate by dividing the ventilation requirement (CFM) above capacity of exhaust unit(s) used. Capacity of a unit for purposes of this section is the capacity in cubic feet per minute with fully loaded filters (pressure differential which causes loaded filter warning light to come on) in the machines labeled operating characteristics.
8. Add one additional unit as a backup in case of equipment failure or machine shutdown for filter changing.
9. Locate exhaust unit(s) so that makeup air enters work area primarily through decontamination facilities and traverses work area as much as possible. This may be accomplished by positioning the unit(s) at a maximum distance from the worker access opening or other makeup air sources.
10. Vent to outside of building, unless authorized in writing by The University's Representative.
11. Each unit shall be serviced by a dedicated minimum 115v-20A circuit with overload device tied into an existing building electrical panel which has sufficient spare capacity to accommodate the load of all pressure differential units connected. Dedication of an existing circuit may be accomplished by shutting down existing loads on the circuit.
12. Test pressure differential system before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, start the unit(s) (one at a time). Demonstrate operation and testing of pressure differential system to The University's Representative.
13. Demonstrate of operations of the pressure differential system to The University's Representative will include, but not be limited to, the following:
    a. Plastic barriers and sheeting move lightly in toward work area.
    b. Curtain of decontamination units move lightly in toward work area.
    c. There is a noticeable movement of air through the decontamination unit. Use stroke tube to demonstrate air movement from clean room, and from equipment room to work area.
    d. Use smoke tubes to demonstrate a positive motion of air across all area in which work is to be performed.
    e. Use a differential pressure meter or manometer to demonstrate a pressure difference of at least 0.02 inches (as allowed) of water across <u>every</u> barrier separating the work area from the balance of the building or outside. This is not required in the case of a mini enclosure.
14. Start exhaust units before beginning work (before any asbestos-containing material is disturbed). After abatement work has begun, run units continuously to maintain a constant negative pressure until decontamination of the work area is complete. Do not turn off units at the end of the work shift or when abatement operations temporarily stop.
15. Do not shut down pressure differential system during encapsulating procedures, unless authorized by The University's Representative in writing. Start abatement work at a location farthest from the exhaust units and proceed toward them. If an electric power failure occurs, immediately stop all abatement work and do not resume until power is restored and exhaust units are operating again.
16. At completion of abatement work, allow exhaust units to run as specified to remove airborne fibers that may have been generated during abatement work and cleanup and to purge the work area with clean makeup air. The units may be required to run for a longer time after decontamination, if dry or only partially wetted asbestos material was encountered during any abatement work. In the case of a mini-enclosure the vacuum may be removed and the entrance sealed following encapsulation until the clearance sample is collected.
17. Prior to final air test, remove pre-filter and wipe out inside lip of negative air machine.
18. When a final inspection and the results of final air tests indicate that the area has been decontaminated, exhaust units may be removed from the work area. Before removal from the work area, remove and properly dispose of pre-filter, and seal Intake to the machine with 6-mil polyethylene to prevent environmental contamination from the filters.

D. Work Area Preparation

1. The work area is the location where asbestos-abatement work occurs. It is a variable of the extent of work of the contract. It may be a portion of a room, a single room, or a complex of rooms. A "work area" is considered contaminated during the work, and must be isolated from the balance of the building, and decontaminated at the completion of the asbestos-control work.
2. Pre-clean fixed objects, walls and floor surfaces within the proposed work areas using HEPA filtered vacuum equipment and wet cleaning methods as appropriate.
3. Seal all openings, supply and exhaust vents, and convectors within ten feet of the work area with 6-mil polyethylene sheeting secured and completely sealed with plastic adhesion tape.
4. Contact fire control agencies to review procedures prior to start of work.
5. Provide flame resistant polyethylene sheeting that conforms to requirements set forth by the National Fire Protection Association Standard 701, Small Scale Fire Test for Flame-resistant Textiles and Films. Provide largest size possible to minimize seams, four- or six- mils thick, frosted or black.
6. Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene and supporting surface.
7. Completely isolate the work area from other parts of the building so as to prevent asbestos-containing dust or debris from passing beyond the isolated area. Should the area beyond the work area(s) become contaminated with asbestos-containing dust or debris as a consequence of the work, clean those areas in accordance with the procedures indicated in Paragraph "Decontamination Procedures." All such required cleaning or decontamination shall be performed at no additional cost to The University.
8. Place all tools (i.e., scaffolding, staging) necessary for the work in the area to be isolated prior to erection of plastic sheeting temporary enclosure.
9. Disable ventilation systems or any other system bringing air into or out of the work area. Disable system by disconnecting wires, removing circuit breakers, by lockable switch or other positive means that will prevent accidental premature restarting of equipment.
10. Remove and dispose of all electrical and mechanical items, such as lighting fixtures, clocks, diffusers, registers, escutcheon plates, etc., which cover any part of the surface on which work is to be performed.
11. All general construction items such as cabinets, casework, doors and window trim, moldings, ceilings, trim, etc., which cover the surface of the work as required to prevent interference with the work. To be performed by The University: clean, decontaminate and reinstall all such materials, upon completion of all removal work with materials, finishes, and workmanship to match existing installations before start of work.
12. Permit Access to the work area only through the Decontamination Unit. All other means of access shall be closed off and sealed and warning signs displayed on the clean side of the sealed access.
13. Provide Warning Signs at each visual and physical barriers reading as follows in both English and Spanish:

Legend	Notation
KEEP OUT	3" Sans Serif Gothic or Block
BEYOND THIS POINT	1" Sans Serif Gothic or Block
ASBESTOS ABATEMENT WORK	1" Sans Serif Gothic or Block
IN PROGRESS	1" Sans Serif Gothic or Block
BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH	14 Point Gothic

14. Alternate methods of containing the work area may be submitted to The University's Representative for approval. Do not proceed with any such method(s) without prior written approval of The University's Representative.
15. Individually seal all ventilation openings (supply and exhaust), lighting fixtures, clocks, doorways, windows, convectors and speakers, and other openings into the work area with plastic adhesion tape alone or with polyethylene sheeting at least 4-mil in thickness, taped securely in place with

plastic adhesion tape. Maintain seal until all work including Project Decontamination is completed. Take care in sealing off lighting fixtures to avoid melting or burning of sheeting.

16. Provide sheet plastic barriers at least 6-mil in thickness as required to completely seal openings from the work area into adjacent areas. Seal the perimeter of all sheet plastic barriers with plastic adhesion tape or spray cement.
17. Where applicable, construct framing of the containment out of fire-treated wood or aluminum studs. Mini-enclosure frames may be constructed of Polyvinyl Chloride (PVC) tubing.
18. Cover all walls in work area extending to the underside of the ceiling grid system with one layer of polyethylene sheeting, at least 6-mil in thickness, mechanically supported and sealed with plastic adhesion tape or spray-glue in the same manner as "Critical Barrier" sheet plastic barriers. Tape all joints with plastic adhesion tape. Contractor shall be responsible for the repair of damaged wall finishes.
19. Cover floor with two layers of 6-mil polyethylene sheeting (exclude for floor tile and adhesive).
20. Provide Pressure Differential System per Paragraph “Pressure Differential System.”
21. If the enclosure barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, then add the affected area to the work area, enclose it as required by this section of the specification and decontaminate it as described in Paragraph “Decontamination Procedures.”
22. Establishing a Mini-Containment area:
    - a. Establish a work area so that unauthorized entry is prevented; Construct a two-compartment fire-treated wood frame around the work area; install one layer 6-mil polyethylene sheeting to structural members and two layers 6 mil polyethylene sheeting to the floor. Exception: no floor is required if mini-containment is being constructed to perform a floor tile activity. Seal all edges to the wall, ceiling, and floor surfaces with duct tape. Install viewing inspection windows, where feasible.
    - b. Seal all penetrations with duct tape such as pipes, electrical conduits, or ducts contained within the mini-containment.
    - c. Install triple 6-mil polyethylene flaps at both doorways. Place the portable sprayer with clean water, disposable towels, and a pre-labeled disposal bag in the airlock.
    - d. Install appropriate signs on outside of the mini-containment area.
    - e. Install HEPA vacuum; extend hose into mini-containment area for general vacuuming, negative air, and cleaning of disposal suit.
    - f. Accumulate all loose materials for disposal. Place in an approved container. Apply appropriate labels. Adequately wet clean all wall, floor, tool and equipment surfaces.
    - g. Abatement worker must wear two disposable suits. Remove the outer suit in work area and place in a plastic bag. Enter the airlock.
    - h. In air lock, wet wipe the respirator and wash hands with clean water. Remove the respirator and place in a clean plastic bag. Proceed to the remote shower unit where the inner suit may be removed.

E. Worker Protection

1. This section describes the equipment and procedures required for protecting workers against asbestos contamination and other work place hazards except for respiratory protection.
2. Respiratory Protection is specified in Paragraph “Respiratory Protection.”
3. Train in accordance with EPA’s Model Accreditation Plan, 40 CFR 763 - Asbestos, all workers in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. Include but do not limit the topics covered in the course to the following:
    - a. Methods of recognizing asbestos.
    - b. Health effects associated with asbestos.
    - c. Relationship between smoking and asbestos in producing lung cancer.
    - d. Nature of operations that could result in exposure to asbestos.
4. Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

    Engineering controls

Work practices
Respirators
Housekeeping procedures
Hygiene facilities
Protective clothing
Decontamination procedures
Emergency procedures
Waste disposal procedures
Appropriate work practices for the work
Requirements of medical surveillance program
Review of OSHA 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos
Pressure differential systems
Work practices including hands on or on job training
Personal decontamination procedures
Air monitoring, personal and area

5. Provide medical examinations for all workers who may encounter an airborne fiber level of 0.1 f/cc or greater for an 8 hour time weighted average. In the absence of specific airborne fiber data, provide medical examination for all workers who will enter the work area for any reason. Examination shall, at minimum, meet OSHA requirements as set forth in 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos. In addition, provide an evaluation of the individual’s ability to work in environments capable of producing heat stress in the worker.
6. Before start of work Contractor shall submit the following to The University's Representative for review. Do not start work until receipt of Owner’s Representative.
   a. An original signed copy of the Certificate of Worker’s Acknowledgement found at the end of this specification, for each worker who is to be at the job site or enter the work area.
   b. Courses outline or name of institution providing the worker training course.
   c. Report from medical examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area.
7. Provide disposable full-body coveralls and disposable head covers, and require that they be worn by all workers in the work area. Provide a sufficient number for all required changes, for all workers in the work area.
8. Provide work boots with non-skid soles, and where required by OSHA, foot protectives, for all workers. Provide boots at no cost to workers. Paint uppers of all boots red with water proof enamel. Do not allow boots to be removed from the work area for any reason, after being contaminated with asbestos-containing material. Dispose of boots as asbestos contaminated waste at the end of the work.
9. Provide head protectives (hard hats) as required by OSHA for all workers, and provide four spares for use by Owner’s Representative, and Owner. Label hats with same warning labels as used on disposal bags. Require hard hats to be worn at all times that work is in progress that may potentially cause head injury. Provide hard hats with plastic strap type suspension. Require hats to remain in the work area throughout the work. Thoroughly clean, decontaminate and bag hats before removing them from work area at the end of the work.
10. Provide eye protectives (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity which may potentially cause eye injury.
11. Provide work gloves to all workers and require that they be worn at all times in the work area. Do not remove gloves from work area. Dispose of gloves as asbestos contaminated waste at the end of the work.
12. Respirators, disposable coveralls, head covers, and footwear covers shall be provided by the contractor for The University, Owner’s Representative, and other authorized representatives who may inspect the job site.
13. Provide worker protection as required by the most stringent OSHA and/or EPA standards applicable to the work. The following procedures are minimums to be adhered to regardless of fiber count in the work area.

14. Each time work is entered, remove all street clothes in the changing room of the Personnel Decontamination Unit and put on new disposable coverall, new head cover, and a clean respirator. Proceed through shower room to equipment room and put on work boots.
15. In the event a mini-enclosure is used refer to Paragraph "Work Area Preparation" for personal decontamination procedures.

F. Respiratory Protection

1. Instruct and train each worker involved in asbestos abatement or maintenance and repair of friable asbestos-containing materials in proper respiratory use and require that each worker always wear a respirator, properly fitted on the face in the work area from the start of any operation which may cause airborne asbestos fibers until the work area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the work place or as required for other toxic or oxygen-deficient situations encountered.
2. Except to the extent that more stringent requirements are written directly into the Contract Documents, the following regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies were bound herewith. Where there is a conflict in requirements set forth in these regulations and standards meet the more stringent requirement.
   a. OSHA - U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Standards 29 CFR 1910, Section 1001 and Section 1910.134.29 CFR 1926.
   b. ANSI - American National Standard Practices for Respiratory Protection. ANSI Z88.2-1980.
   c. NIOSH - National Institute for Occupational Safety and Health.
   d. MSHA - Mine Safety and Health Administration.

G. Type Of Respiratory Protection Required

1. Provide Respiratory Protection as indicated in paragraph below. Where paragraph below does not apply, determine the proper level of protection by dividing the expected or actual airborne fiber count in the work area by the "protection factors" given below. The level of respiratory protection which supplies an airborne fiber level inside the respirator, at the breathing zone of the wearer, at or below 0.01 fibers/cubic centimeter is the minimum level of protection allowed.
2. Eight-hour Time Weighted Average (TWA) of asbestos fibers to which any worker may be exposed shall not exceed 0.1 fibers/cubic centimeter.
3. For purposes of this section fibers are defined as all fibers regardless of composition as counted in the OSHA Reference Method (ORM), NIOSH P&CAM 239 or 7400 procedure, or asbestos fibers of any size as counted using either a scanning or transmission electron microscope.
4. Require that respiratory protection be used at all times that there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental.
5. Require that a respirator be worn by anyone in a work area at all tunes, regardless of activity, during a period that starts with any operation which could cause airborne fibers until the area has been cleared for re-occupancy.

H. Respiratory Protection Factor

Respirator Type	Protection Factor
Air purifying: Negative pressure respirator High efficiency filter Half facepiece	10
Air purifying: Negative pressure respirator High efficiency filter Full facepiece	50
Powered-air purifying (PAPR):	100

Positive pressure respirator High efficiency filter Half or Full facepiece	
Type C supplied air: Positive pressure respirator continuous-flow Half or full facepiece	100
Type C supplied air: Positive pressure respirator pressure demand Full facepiece	1000
Type C supplied air: Positive pressure respirator pressure demand Full facepiece Equipped with an auxiliary positive pressure Self-contained breathing apparatus (SCBA)	over 1000
Self-contained breathing apparatus (SCBA): Positive Pressure respirator Pressure demand Full facepiece	over 1000

I. Air Purifying Respirator

1. Provide half face or full face type respirators. Equip full-face respirators with a nose cup or other anti-fogging device as would be appropriate for use in air temperatures less than 32 degrees Fahrenheit.
2. Provide, at a minimum, HEPA type filters labeled with NIOSH and MSHA certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-Containing Dusts and Mists" and color coded in accordance with ANSI Z228.2 (1980). In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH/MSHA Certification.
3. Supply with a sufficient quantity of respirator filters approved for asbestos, so that workers can change filters during the work day. Require that respirators be wet-rinsed, and filters discarded, each time a worker leaves the work area. Require that new filters be installed each time a worker re-enters the work area. Store respirators and filters at the job site in the changing room and protect totally from exposure to asbestos prior to their use. <u>Do not use single use, disposable or quarterface respirators.</u>

J. Powered Air Purifying Respirator (PAPR)

1. Provide full-facepiece type respirators. Provide nose-cups for full-facepiece respirators. Provide, at a minimum, HEPA type cartridges approved by NIOSH/MSHA and certified for use in atmospheres containing asbestos dusts.
2. Provide, at a minimum, one extra battery pack for each respirator so that one can be charging while one is in use.
3. Provide non-cloth belts capable of being decontaminated in shower.
4. Supply with a sufficient quantity of high efficiency respirator filters approved for asbestos so that workers can change filters at any time that flow through the face piece decreases to the level at which the manufacturer recommends filter replacement. Require that regardless of flow, filter cartridges be replaced after 40 hours of use. Require that HEPA elements in filter cartridges be protected from wetting during showering. Require entire exterior housing of respirator including blower unit, filter cartridges, hoses, battery pack, face mask, belt, and cords to be washed each time a worker leaves the work area. Caution should be used to avoid shorting battery pack during washing.

K. Required Respiratory Protection
  1. Regardless of airborne fiber levels, require the following minimum level of respiratory protection:
    a. Half-face air purifying respirators may be used during set-up of the containment and removal of the material so long as fiber counts inside the respirator do not exceed .01 f/cc fibers per cubic centimeter.

L. Decontamination Units -Three-Stage
  1. Provide a Personnel Decontamination Unit consisting of a serial arrangement of rooms or spaces, Changing Room, Shower Room, Equipment Room adjacent to each full containment area.
  2. Require all persons without exception to pass through this decontamination unit for entry into and exiting from the work area for any purpose. Do not remove equipment or materials through Personnel Decontamination Unit.
  3. Changing (Clean) Room:
    a. Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing.
    b. Locate so that access to work area from changing room is through shower room.
    c. Separate changing room from the building by a double-sheeted polyethylene flapped doorway.
    d. Provide a sub-panel in changing room to accommodate all removal equipment. Power sub-panel directly from a building electrical panel. Connect all electrical branch circuits in the decontamination unit and particularly any pumps in the shower room to a ground-fault circuit protection device.
  4. Shower Room:
    a. Provide a completely watertight operational shower to be used for transit by cleanly dressed workers heading for the work area from the changing room, or for showering by workers headed out of the work area after undressing in the equipment room.
    b. Construct a room by providing a shower pan and two shower walls in a configuration that will cause water running down walls to drip into the pan. Install a freely draining wood floor in the shower pan at the elevation of the top of the pan.
    c. Separate this room from the rest of the building, drying room, and airlock with airtight walls fabricated of 6-mil polyethylene.
    d. Provide splash proof entrances to Drying Room and Airlock.
  5. Equipment Room (contaminated area):
    a. Require work equipment, footwear, and additional contaminated work clothing to be left here. This is a change and transit area for workers. Separate this room from the work area by a 6-mil polyethylene flap doorway.
    b. Separate this room from the rest of the building, the shower room and the work area with air tight walls fabricated of 6-mil polyethylene.
  6. Clean Room: Provide Clean Room to isolate the holding room from the building exterior.
  7. Load-out Area:
    a. The load-out area is the transfer area from the building to a truck or dumpster.
    b. Wet wipe bags before they are passed through the equipment decon-chamber.
    c. When cleaning is complete pass items into holding room. Close all doorways except the doorway between the holding room and the Clean Room.
    d. Workers from the area outside the containment area enter holding area and remove decontaminated equipment and/or containers for disposal.
    e. Require these workers to wear full protective clothing and appropriate respiratory protection.
    f. At no time is a worker from an uncontaminated area to enter the enclosure when a removal worker is inside.
    g. Post an approximately 20 inch x 14 inch manufactured caution sign at each entrance to the work area displaying the following legend with letter sizes and styles of a visibility required by OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos.

<u>LEGEND</u>
DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED
IN THIS AREA

h. Provide spacing between respective lines at least equal to the height of the respective upper line.
i. Additional Signage: Shall also be posted in accordance with OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA
DANGER
ASBESTOS
CANCER AND LUNG HAZARD
KEEP OUT

j. Post an approximately 10 inch by 14 inch manufactured sign at each entrance to each work area displaying the following legend with letter sizes and styles of a visibility at least equal to the following:

LEGEND	NOTATION
No Food, Beverages or Tobacco Permitted	3/4 inch Block
All Persons Shall Don Protective Clothing (Coverings) Before Entering the Work Area	3/4 inch Block
All Persons Shall Shower Immediately After Leaving Work Area and Before Entering the Changing Area	3/4 inch Block

M. Decontamination Procedures
1. Contractor shall require all workers and visitors to adhere to the following personal decontamination procedures whenever they leave the work area:

a. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area.
b. When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the Equipment Room.
c. Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
    1) Thoroughly wet body including hair and face. If using a PAPR, hold blower unit above head to keep canisters dry.
    2) With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.

        3) Take a deep breath, hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breathe.
        4) Carefully wash face-piece of respirator inside and out.
    d. If using PAPR, shut down in the following sequence, first cap inlets to filter cartridges, then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack as this will short out and destroy battery.
        1) Shower completely with soap and water.
        2) Rinse thoroughly.
        3) Rinse shower room walls and floor prior to exit.
        4) Proceed from shower to changing room and change into street clothes or into new disposable work items.
    e. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area with a half or full face cartridge type respirator:
        1) When exiting area, remove disposable coveralls, disposable headcovers, and disposable footwear covers or boots in the equipment room.
        2) Still wearing respirators, proceed to showers. Showering is <u>mandatory</u>. Care must be taken to follow reasonable procedures in removing the respirator and filters to avoid asbestos fibers while showering. The following procedure is required as a minimum:
        3) Thoroughly wet body from neck down.
        4) Wet hair as thoroughly as possible without wetting the respirator filter if using an air purifying type respirator.
        5) Take a deep breath, hold it and/or exhale slowly, complete wetting of hair, thoroughly wetting face, respirator and filter (air purifying respirator). While still holding breath, remove respirator and hold it away from face before starting to breath.
        6) Dispose of wet filters from air purifying respirator.
        7) Carefully wash facepiece of respirator inside and out.
        8) Shower completely with soap and water.
        9) Rinse thoroughly.
        10) Rinse shower room walls and floor prior to exit.
        11) Proceed from shower to changing room and change into street clothes or into new disposable work items.

N. Project Decontamination
    1. If the asbestos abatement work is on damaged or friable materials, then the building space is deemed contaminated before start of the work and in need of decontamination. In this case, the procedure includes two cleanings of the primary barrier plastic prior to its removal and two cleanings of the room surfaces to remove any new or existing contamination.
    2. Work of this section includes the decontamination of air in the work area which has been, or may have been contaminated by the elevated airborne asbestos fiber levels generated during abatement activities, or which may previously have had elevated fiber levels due to friable materials in the space.
    3. Work of this section also includes the cleaning, decontamination, and removal of temporary facilities installed prior to abatement work and decontamination of all surfaces (ceiling, walls, floor) of the work area, and all furniture or equipment in the work area.
    4. First Cleaning
        a. Carry out a first cleaning of all surfaces of the work area including items of remaining sheeting, tools, scaffolding and/or staging by use of damp-cleaning and mopping, and/or a HEPA filtered vacuum. (Note: A HEPA vacuum will fail if used with wet material). Do not perform dry dusting or dry sweeping. Use each surface of a cleaning cloth one time only and then dispose as contaminated waste. Continue this cleaning until there is no visible

debris from removed materials on plastic sheeting or other surfaces. Upon authorization of Owner's Representative proceed with encapsulation of substrate.

    b. Perform encapsulation of substrate where required at this time. Maintain pressure differential system in operation during encapsulation work. Allow encapsulant to dry before proceeding with removal of Secondary layer of plastic.

5. Second Cleaning
    a. Upon authorization of Owner's Representative, remove all Primary Barrier sheeting and Material Decontamination Unit, if there is one, leaving only the following:
        1) Critical Barrier which forms the sole barrier between the work area and other portions of the building or outside.
        2) Critical Barrier Sheeting over lighting fixtures and clocks, ventilation openings, doorways, convectors, speakers and other openings.
        3) Personnel Decontamination Unit.
        4) Pressure Differential System in continuous operation.
    b. Remove all filters in Air Handling System(s) and dispose of as asbestos-containing waste.
6. Final Cleaning: Carry out a final cleaning of all surfaces in the work in the same manner as the first cleaning immediately after removal of primary plastic. This cleaning is now being applied to existing room surfaces. Take care to avoid water marks or other damage to surfaces.
7. Visual Inspection: Perform a complete visual inspection with Owner's Representative of the entire work area including decontamination unit, all plastic sheeting, seals over ventilation openings, doorways, windows, and other openings; look for debris from any sources, residue on surfaces, dust or other matter. If any such debris, residue, dust or other matter is found repeat cleaning and continue decontamination procedure from that point. When the area is visually clean, complete the certification at the end of this section.
8. Final Air Sampling
    a. After the work area is found to be visually clean, air samples will be taken and analyzed in accordance with the procedures set forth in Paragraph “Powered Air Purifying Respirator (PAPR).
    b. If Release Criteria are not met, repeat cleaning and continue decontamination procedure from that point.
    c. If Release Criteria is met, remove the interior of the decontamination unit leaving in place only the Critical Barriers separating the work area from the rest of the building and the operating negative pressure system.
    d. Any small quantities of residual material found upon removal of the plastic sheeting shall be removed with a HEPA filtered vacuum cleaner and local area protection. If significant quantities, as determined by The University's Representative, are found then the entire area affected shall be decontaminated as specified herein for the cleaning.

O. Work Area Clearance
1. Air Monitoring
    a. Visual Inspection is required as a prerequisite of air testing.
    b. To determine if the elevated airborne asbestos structure concentration during abatement operations have been reduced to the specified level, The University's Representative will secure samples and analyze them according to the following procedures.
2. Aggressive Sampling
    a. All air samples will be taken using aggressive sampling techniques as follows. (There are no standards available for flow rate of leaf blowers or large fans. However, this information is not critical to the success of the procedure).
    b. Before sampling pumps are started, the exhaust from forced-air equipment (leaf blower with at least 1 horsepower electric motor) will be swept against all walls, ceilings, floors, ledges and other surfaces in the room. This procedure will be continued for five minutes per 10,000 cubic feet of room volume.
    c. Air samples will be collected in areas subject to normal air circulation away from room corners, obstructed locations, and sites near windows, doors or vents.
3. Schedule of Air Samples

a. General: The number and volume of air samples taken and analytical methods used by The University's Representative will be in accordance with the following schedule. Sample volumes given may vary depending upon the analytical instruments used. In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM of TEM analysis.

b. Transmission Electron Microscopy (TEM) Samples:

1) In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM or TEM analysis as follows:

2) Samples will be collected on 25 mm cassettes with filter media: TEM - 0.45 micrometer mixed cellulose ester or 0.40 micrometer polycarbonate, with 5.0 micron mixed cellulose ester backing filter.

Location **Sampled**	Number of **Samples**	Detection **Limit** (f/cc)	**Minimum** Volume (Liters)	**Rate** LPM
Each Work Area	5	0.005	1,300	2-10

3) TEM Analysis will be performed using the analysis method set forth in the AHERA Regulation 40 CFR Part 763 Appendix A.

4) Asbestos Structures referred to in this Section include asbestos fibers, bundles, clusters, or matrices, as defined by method of analysis.

5) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

c. Phase Contrast Microscopy (PCM) Samples:

1) In each homogeneous work area after completion of all cleaning work, samples may be taken and analyzed as follows:

2) Samples will be analyzed by PCM for clearance in areas where ceiling tile and/or pipe insulation are removed

3) Samples will be collected on 25 mm cassettes with filter media: PCM - 0.8 micrometer mixed cellulose ester.

Location Sampled	**Number of Samples**	**Detection Limit** (s/cc)	**Minimum Volume** (Liters)	**Rate** LPM
Each Work Area	1-5	0.01	2,400	2-10

4) PCM Analysis: Fibers on each filter will be measured using the NIOSH 7400 Method entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987.

5) Fibers: Referred to in this section include fibers regardless of composition as counted by the phase contrast microscopy method used

6) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

4. Failure of Clearance Sampling: Should results from analysis of final clearance air samples not meet the specified criteria, Contractor will be responsible for the payment of all costs, including Consultant's time for subsequent clearance air sampling. The costs associated with subsequent re-sampling for final clearance shall be deducted from the Contractor's final payment of the contract amount.

P. Removal Of Pipe Insulation

1. The work of this section applied to the removal of asbestos-containing Pipe Insulation.

a. Place one layer of 6-mil fire retardant polyethylene sheeting directly below the work. The sheet shall be of sufficient size to completely wrap the pipe once it has been removed.

b. Thoroughly wet the ends of the pipe with amended water and scrape off a minimum of 6 inches of asbestos wrap from both ends of the pipe. Immediately place the wetted material into pre-labeled asbestos disposal bag(s).

c. Detach the pipe at each scraped end and place the pipe onto one sheet of 6-mil fire retardant polyethylene sheeting. Wrap the pipe with the 6-mil fire retardant polyethylene sheeting. Contractor shall wrap the pipe with a second sheet of 6-mil, fire retardant polyethylene sheeting and label as asbestos-containing material. Dispose of the bag(s) and duct in accordance with the Paragraph "Handling and Disposal of Asbestos Contaminated Waste" of this specification.

d. Upon clearance from The University's Representative, Contractor shall remove the 6-trail, fire retardant polyethylene sheeting from the openings.

Q. Glove Bag Removal

1. The work of this section applies to full containment or glovebag removal.
2. Isolate the area in accordance with Paragraph “Temporary Facilities.”
3. Construct a decontamination unit as described in Paragraph “Decontamination Units” and attach to the work area.
4. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph “Pressure Differential System.”
    a. Upon approval of the enclosure by The University's Representative, Contractor may proceed to remove the material using the following method.
    b. Thoroughly wet to satisfaction of Owner's Representative, asbestos-containing insulation to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions. If insulation is covered with canvas, Contractor will wet the exterior covering and slice it with utility knife while saturating the material.
    c. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
    d. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
    e. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
    f. Contractor must always clean area of visible asbestos debris prior to end of shift.
5. These procedures shall be followed to remove pipe insulation elbows:
    a. Install critical barriers to isolate the work site. Install 2 or 3 Stage Decontamination Units.
    b. HEPA vacuum the work site.
    c. Provide negative air machine in addition to those required, in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 2-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
    d. Locate intake of duct so that airflow is horizontally and slightly downward into intake. Replace primary filter on negative air machine at an interval of no greater than 30 minutes. Allow no more than one scraping or brushing activity per negative air machine.
    e. Check pipe where the work will be performed. Wrap damaged (broken lagging, hanging, etc.), pipe in 6 mil plastic and "candy-stripe" with duct tape. Place one layer of duct tape around undamaged pipe at each end where the glovebag will be attached.
    f. Place necessary tools into pouch located inside glovebag. This will usually include: bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and pre-wetted cloth.
    g. Place one strip of plastic adhesion tape along the edge of the open top slit of glove bag for reinforcement.
    h. Place the glove bag around section of pipe to be worked on and staple top together through reinforcing tape. Next, tape the ends of glovebag to pipe itself, where previously covered with plastic or tape.

i. Use smoke tube and aspirator bulb to test seal. Place tube into water sleeve (two-inch opening to glovebag) squeezing bulb and filling bag with visible smoke. Remove smoke tube and twist water sleeve closed. While holding the water sleeve tightly, gently squeeze glovebag and by using a flashlight, look for smoke leaking out, (especially at the top and ends of the glovebag). If leaks are found, tape closed using plastic adhesion tape and re-test.
j. Insert wand from garden sprayer through water sleeve. Plastic adhesion tape water sleeve tightly around the wand to prevent leakage.
k. One person places his hands into the long-sleeved gloves while the second person directs garden sprayer at the work.
l. Use bone saw, if required, to cut insulation at each end of the section to be removed. A bone saw is a serrated heavy gauge wire with ring-type handles at each end. Throughout this process, spray amended water or removal encapsulant on the cutting area to keep dust to a minimum.
m. Remove insulation using putty knives or other tools. Place pieces in bottom of bag without dropping.
n. Rinse all tools with water inside the bag and place back into pouch.
o. Using scrub brush, rags and water, scrub and wipe down the exposed pipe. (Inexpensive horse rub-down mittens work well for this).
p. Remove water wand from water sleeve and attach the small nozzle from HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag.
q. Remove the vacuum nozzle, twist water sleeve closed and seal with plastic adhesion tape.

R. Handling And Disposal Of Asbestos-Containing Waste
1. All waste and asbestos contaminated waste shall be double bagged in pre-labeled 6-mil airtight puncture resistant bags. Labeling shall be in accordance with OSHA and EPA requirements.
   a. Bags of asbestos-containing waste shall be sealed with tape in the work area. Asbestos waste shall not be allowed to dry out prior to sealing bags. While in the work area, bags shall be decontaminated of any bulk debris by wet wiping. Bags shall be pre-labeled in accordance with OSHA and EPA.
   b. The Contractor shall ensure that the sealed bags are transported to the waste disposal site.
2. The Contractor shall establish a manifest system to enable The University to report the quantity of asbestos waste being deposited at the landfill. Contractor shall report the quantity of waste in pounds or tons as appropriate. The Contractor must be able to demonstrate custody over all asbestos waste from the time it is removed from the work area until it is deposited at the land fill.
   a. Copies of the manifest and any receipts generated during the handling and disposal process shall be provided to Owner's Representative and The University.
   b. Final manifest and documents must be provided to Owner's Representative and The University within two weeks of the removal of the asbestos materials from the site by the waste hauler.

S. Encapsulation Of Asbestos-Containing Materials
1. General provisions of Contract, including General and Supplementary Conditions and Division 01, apply to work of this section.
   a. The work includes the sealing of all piping or vessels from which asbestos-containing insulation has been removed with one coat of a lock down encapsulant.
   b. Where repair work is being performed, the end will be sealed with a minimum of one coat of bridging encapsulant.
2. Submittals
   a. Product Data: Submit manufacturer's technical information including label analysis and application instructions for each material proposed for use.
   b. Installation Instructions: Submit manufacturer's installation instructions with specific project requirements noted.
   c. Performance Warrantee: Submit manufacturer's performance guarantee.

   d. Certification: Submit written approval of entity installing the encapsulant from encapsulant manufacturer.
   e. Material Safety Data Sheet: Submit the Material Safety Data Sheet, or equivalent, in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.
3. Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
   a. Name or title of material
   b. Manufacturer's stock number and date of manufacture
   c. Manufacturer's name
   d. Thinning Instructions
   e. Application Instructions
4. Deliver materials together with a copy of the OSHA Material Safety Data Sheet for the material.
5. Job Conditions
   a. Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.
6. Quality Assurance
   a. Installation of Spray-on Encapsulation Materials: Install spray-on materials by a firm and personnel approved by the manufacturer of the primary materials.
   b. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Performance Warranty: Submit written Performance Warranty, executed by the manufacturer and co-signed by the Contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, non-foreseeable ambient exposures or other causes beyond anticipated conditions and manufacturer's/contractor's control.
   d. Compatibility: Selection and use of encapsulant shall be compatible with replacement materials. Submit manufacturer's data indicating compatibility with replacement materials.
7. Product Selection
   a. Encapsulants: Provide penetrating or bridging type encapsulants specifically designed for application to asbestos-containing material.
   b. Standards: Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Fire Safety: Use only materials that have a flame spread index of less than 25, when dry, when tested in accordance with ASTM E84.
8. Manufacturers
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the work, include, but are not limited to the following:
      1) Penetrating Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
      2) Bridging Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
9. General
   a. Prior to applying any encapsulating material, ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from The University's Representative before proceeding with the encapsulating work.

  - b. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.
- 10. Worker Protection
  - a. Before beginning work with any material for which a Material Safety Data Sheet has been submitted, provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.
  - b. In addition to protective breathing equipment required by OSHA requirements or by this specification, use painting pre-filters on respirators to protect the dust filters when organic solvent based encapsulants are used.
- 11. Substrate
  - a. Apply lock down encapsulant to all substrate after all asbestos-containing materials have been removed. Apply in strict accordance with the manufacturer's printed instructions for use of the encapsulation as an asbestos coating. Any deviations from such printed instructions shall be approved by The University's Representative in writing prior to commencing work.
  - b. Apply encapsulant with an airless spray gun with air pressure and nozzle orifice as recommended by the encapsulant manufacturer.

T. Removal Of Floor Tile

- 1. This section applies to the removal of floor tile.
  - a. Prior to start of work, wet wipe all surfaces including floor tile to remove any visible dust.
  - b. Isolate the room by sealing hallway or doors and installing critical barriers on all ducting, windows and other penetrations of the room, in the specified area. Install a splash guard a minimum of 4 feet high on the walls of the room with one layer of 6-mil fire retardant poly.
  - c. Install a two-stage decontamination configuration contiguous (under certain conditions may be remote) with the work in accordance with Paragraph “Decontamination Units.”
  - d. Using water or amended water in a Hudson-type sprayer or garden sprayer, lightly mist the area where the material is to be removed. This may take several passes with the hose of the sprayer. Allow time for the water to soak into the material.
  - e. Immediately place individual tiles in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place the bag into a second prelabeled disposal bag. Tape shut the second bag.

U. Removal Of Fireproofing

- 1. The work of this section applies to the removal of all asbestos containing fireproofing including all over-spray that may be located on concrete block, columns, metal deck, beams, fixtures conduit and ducting.
  - a. Isolate the floor per Paragraph “Temporary Enclosure.”
  - b. Construct a decontamination unit as described in Paragraph “Decontamination Units” and attach to the work area.
  - c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph “Temporary Pressure Differential and Air Circulation System.”
  - d. Upon approval of the enclosure by The University's Representative, contractor may proceed to remove the material using the following method.
  - e. Pre-clean columns, beams, electrical, mechanical and plumbing systems in the work area using wet wipe and HEPA vacuuming methods. Mask off with flame retardant polyethylene sheeting to protect from contamination during bulk abatement.
  - f. Thoroughly wet to satisfaction of Owner's Representative, asbestos-containing fireproofing to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions.

- g. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
- h. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
- i. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
- j. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 12" diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
- k. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on pressure differential machine at an interval of no greater that 30 minutes. Allow no more than one scraping or brushing activity per pressure differential machine.

V. Removal Of Wall Plaster: HEPA vacuum work site.

1. Place two layers of 6-mil flame retardant polyethylene sheeting on the floor adjacent to the wall to be demolished. Pull the wall down in manageable sections onto the polyethylene sheeting. Control dust and fiber release by misting the air and lightly wetting the material with amended water from a Hudson-type sprayer or garden sprayer as it is demolished.
2. Wrap the first layer of polyethylene sheeting around the material and seal with duct tape. Wrap the second layer of polyethylene sheeting around the bundle and seal with duct tape.
3. Label and dispose of the entire bundle.
4. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is unto the work area, oriented in a direction away from the work. Extend a 12-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
5. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on negative air machine at an interval of no greater that 30 minutes.

W. Clean-Up Of Asbestos-Containing Debris On Ceiling Tile Or Solid Ceiling

1. This section applies to the decontamination of the entire plaster ceiling, removal of existing fiberglass on duct work and removal of all batt insulation covering the existing plaster ceiling.
   - a. Isolate the floor per Paragraph "Temporary Facilities."
   - b. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area. General Contractor will give direction regarding exact location of decontamination unit(s).
   - c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Temporary Pressure Differential and Air Circulation System."
   - d. Upon approval of the enclosure by The University's Representative, contractor may proceed to remove the material using the following method:
2. These procedures shall be followed to for clean up of asbestos-containing debris on existing plaster ceiling:
   - a. This work will be performed prior to the removal of fireproofing. The isolation of the work area is considered essential to the pre-cleaning activities for the total area. Isolate the area in accordance with Paragraph “Temporary Facilities.”
   - b. Remove asbestos-containing debris and fiberglass batt and duct insulation and decontaminate the area using the following procedures:
     - 1) Remove all small debris with the HEPA vacuum.
     - 2) Gently mist all fiberglass insulation, remove from ducts and ceiling and place into pre-labeled hazardous disposal bags and dispose of in accordance with Paragraph “Disposal of Asbestos Containing Waste Material.”

3) Exposure of ducting will expose all fireproofing overspray, this material may be removed during the removal of fireproofing from decks and beams.
4) Pick up all large visible debris on the ceiling or any horizontal surfaces and place in the bottom of a 6-mil polyethylene disposal bag conforming to the requirements of Paragraph “Disposal of Asbestos-Containing Waste.” Place pieces in the bag without dropping and avoiding unnecessary disturbance and release of material.
5) HEPA vacuum the entire plaster ceiling surface.

c. Upon completion of the decontamination of the area request a visual inspection of the ceiling and other horizontal surfaces. This area will be considered a portion of work area for the duration of the work and will be included in the final encapsulation of the area.

X. Removal Of Adhesive: This section applies to the removal of all asbestos-containing floor tile and adhesive, sheet vinyl flooring, vinyl floor tile, and baseboard adhesive, etc.

1. Ensure that workers are equipped with proper respiratory protection. In addition to the HEPA cartridges, respirators must also be equipped with organic solvent cartridges.
2. Provide HEPA filtered fan units in the vicinity of the work. Arrange so that units exhaust outside the building. Replace primary filters on HEPA filtered fan units at an interval of no greater than 30 minutes.
3. Apply adhesive removal solvent as recommended by manufacturer after removal of floor tile has been completed.
4. Provide tile adhesive (mastic) remover that meets the following criteria:
   a. Flash Point: 122E or greater.
   b. Special Precautions: No heavy smoke generated if ignited.
   c. Health Effects: Limited to mild skin rash or eye irritation.
   d. Respiratory Protection: MSHA - NIOSH approved Organic vapor cartridges in conjunction with standard HEPA filters.
   e. Petroleum Distillates: None.
   f. Odor: Pine, Citrus or none.

Use of diesel fuel in the removal of tile and baseboard adhesive is strictly prohibited.

5. Remove adhesive in small sections from all areas. Do not allow material to dry out. As adhesive is removed, simultaneously pack rags contaminated with adhesive material into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside of bag and move to material decontamination unit.
6. Upon completion of adhesive removal, thoroughly clean bare substrate of all solvent residue.
7. Place adhesive residue in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place bag into second prelabeled disposal bag. Tape shut the second bag.

CERTIFICATE OF WORKER'S ACKNOWLEDGEMENT

PROJECT NAME: ______________________________

PROJECT ADDRESS: ______________________________

CONTRACTOR: ______________________________

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCER IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with The University for the above project requires that: You be supplied with the proper respirator and be trained in its use. You be trained in safe work practices and in the use of the equipment found on the job. You receive a medical examination. These things are to have been done at no cost to you. By signing this certification you are assuring The University that your employer has met these obligations to you.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators, and informed ofthe type respirator to be used on the above referenced project. I have a copy of the written respiratory protection manual issued by my employers. I have been equipped at no cost with the respirator to be used on the above project.

TRAINING COURSE: I have been trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. The topics covered in the course included the following:

Physical characteristics of asbestos
Health hazards associated with asbestos
Respiratory protection
Use of protective equipment
Pressure differential systems
Work practices including hands-on or on-the-job training
Personal decontamination procedures
Air monitoring, personal and area

MEDICAL EXAMINATION: I have had a medical examination within the last 12 months which was paid for by my employer. This examination included: health history, pulmonary function tests and may have included an evaluation of a chest x-ray.

Signature ______________________ Witness ______________________

Printed Name ______________________ Social Security Number ______________________

CERTIFICATION OF VISUAL INSPECTION

AREA ______________________

In accordance with Paragraph "Project Decontamination" the Contractor hereby certifies that he has visually inspected the work area (all surfaces including pipes, beams, ledges, walls, ceiling and floor, Decontamination Unit, sheet plastic, etc.) and has found no dust, debris or residue.

By: ____________________________________

Signature ________________________________ Date ______________________

Print Name ______________________________

Print Title _______________________________

OWNER'S REPRESENTATIVE CERTIFICATION

The University's Representative hereby certifies that he has accompanied the Contractor on his visual inspection and verifies that this inspection has been thorough and to the best of his knowledge and belief, the Contractor's certification above is a true and honest one.

Signature ________________________________ Date ______________________

Print Name ______________________________________

Print Title _______________________________________

RESPIRATORY PROTECTION PROGRAM

Project Name ____

Location ____

Date ____

Based upon airborne asbestos-fiber counts encountered on previous projects of similar type working on materials similar to those found on the above referenced project. The following level of respiratory protection is proposed for the indicated operations to maintain an Airborne Fiber Count (as measured by the NIOSH 7400 Method) below the specified Permissible Exposure Limit (PEL) inside the respirator face piece.

Operation	Anticipated f/cc	Respiratory Protection	Protection Factor	f/cc in Mask
Installing sheet plastic				
Removing trim in contact with asbestos-containing material				
Removal of architectural finish or fireproofing				
Removal of pipe insulation				
Removal of fitting insulation				
Encapsulation of pipe and boiler insulation				
Gross debris removal				
Cleaning "primary" sheet plastic				
Cleaning "critical" barrier				
Removing Decontamination Unit				
Other				

The Contractor certifies that to the best of his knowledge and belief the above represent a true and accurate representation of Airborne Fiber Counts to be expected for the operations indicated, and are based upon airborne fiber data from past projects with similar materials and operations.

Contractor ______________________________

Signature ______________________________ Date ____________________

Print Name ______________________________ Title ____________________

END OF SECTION 02 82 00 00

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SECTION 02 82 00 00a - REMOVAL OF NONFRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for the removal of nonfriable asbestos-containing materials. Products shall be as follows by the UT Health EHS Department. Installation procedures shall be by the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions

1. ACM: Asbestos Containing material which is any material containing one percent asbestos or more, per the Texas Department of State Health Services Asbestos Rules 2021.
2. Amended Water: Water containing a wetting agent or surfactant with a maximum surface tension of 2.9 Pa 29 dynes per centimeter when tested by ASTM D 1331.
3. Area Sampling: Sampling of asbestos fiber concentrations that approximates the concentrations of asbestos in the theoretical breathing zone but is not collected in the breathing zone of an employee.
4. Asbestos: The term asbestos collectively refers to a naturally occurring mineral known by the following specific names: chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
5. Asbestos Containment Area: That area where asbestos removal operations are performed. The area shall be isolated by barricade tape to assist in the prevention of uncontrolled access by non-qualified persons.
6. Asbestos Fibers: Those fibers having an aspect ratio of at least 3:1 and longer than 5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.
7. Asbestos Permissible Exposure Limit: 0.1 fibers per cubic centimeter of air as an 8-hour time-weighted average measured in the breathing zone as by defined 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers’ health.
8. Background: Ambient air samples were collected in each asbestos abatement work area before the start of work. Samples are collected and archived for 60 days.
9. Contractor: The Contractor is that individual, or entity under contract to The University to perform the herein listed work.
10. Contractor/Supervisor (Asbestos abatement): All licensed individuals must meet the training of the EPA's Model Accreditation Plan.
11. Critical Barrier: Two layers of 6-mil polyethylene sheeting that cover an opening or penetration in a room or area that is to become a negative pressure enclosure.
12. Encapsulation: The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.
13. Encapsulants: Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.
    a. Removal Encapsulant (can be used as a wetting agent)
    b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos-containing material)
    c. Penetrating Encapsulant (used to penetrate the asbestos-containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
    d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos-containing material has been removed).
14. Friable Asbestos Material: Any material containing more than one percent asbestos that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.
15. Glovebag Technique: Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.

16. HEPA Filter Equipment: High-efficiency particulate air (HEPA) filtered vacuum and/or exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.
17. The ODR or UTHSCSA consultant: That qualified person employed directly by The University to monitor, sample, inspect the work, and advise The University.
18. Negative Pressure Enclosure (NPE): That engineering control technique is described as a negative pressure enclosure in 29 CFR 1926.1101.
19. Non-friable Asbestos Material: Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, renovation, removal, or mishap.
20. Personal Sampling: Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed by 29 CFR 1926.1101.
21. Competent Person (CP): A person who has completed training and is therefore accredited under a legitimate State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763 as a Contractor/Supervisor and shall be appropriately licensed according to the Statutes of the State in which the work is to be performed.
22. TEM: Refers to Transmission Electron Microscopy.
23. Time Weighted Average (TWA): The TWA is an 8-hour time-weighted average airborne concentration of asbestos fibers.
24. Wetting Agent: A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 2.9 Pa 29 dynes per centimeter when tested by ASTM D 1331.

C. Requirements

1. Description of Work: The work covered by this section includes the handling and control of asbestos-containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment, and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos-containing materials generated by the work. More specific operational procedures shall be outlined in the “Asbestos Abatement Design Specification” called for elsewhere in this specification. The asbestos work includes the use of non-friable removal technique(s) which is governed by 40 CFR 763 as indicated. Provide non-friable removal technique(s) as outlined in this specification for the locations indicated.
2. Medical Requirements: Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.
    a. Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within 12 months before the start of work on this contract. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically, identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."
    b. Medical Records: Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 30 years after termination of employment and make records of the required medical examinations and exposure data available for inspection and copying to The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.
    c. Medical Certification: Submit written certification for each worker and contractor/supervisor, signed by a licensed physician indicating that the worker and contractor/supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1910.134 as prescribed by law.

3. Training: Train all personnel involved in the asbestos control work by the United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or TDSHS' newly adopted EPA Model Accreditation Program referenced in the 2021 rules. The Contractor shall document the training by providing a copy of a current training certification to the UT Health Project Manager for each person assigned to work on this project. Furnish each employee with respirator training and fit testing documentation as required by 29 CFR 1910.134. Provide instruction on the engineering and other hazard control techniques and procedures to be used on this project.
   a. Employee Training: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level by 40 CFR 763.
4. Permits, Licenses, and Notifications: Notify the Texas Department of State Health Services and the UT Health Project Manager in writing 10 working days before commencement of work by 40 CFR 61-SUBPART M or applicable state and local regulations. Obtain necessary permits or licenses in conjunction with asbestos removal, encapsulation, hauling, and disposal. Post the permit and/or license at the work site, visible from a non-controlled area. Notify the local fire department 3 days before removing fire-proofing material from the building including notice that the material contains asbestos.
5. Environment, Safety, and Health Compliance: Comply with the applicable requirements of the current issue of 29 CFR 1926.1101, 40 CFR 61-SUBPART A, and 40 CFR 61-SUBPART M or applicable State or local regulations regarding the handling, storing, transporting, and disposing of asbestos waste materials. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable regulations, or referenced documents vary, the most stringent requirement shall apply.
   a. Site Inspection: While performing asbestos engineering control work, the Contractor shall be subject to an on-site inspection by the Federal, State, or local regulatory agencies and the Contracting Officer or his designated representative. If the work is found to violate Federal, State, or local regulations or this specification, the Contracting Officer or his representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the violation shall be at the Contractor's expense.
6. Respiratory Protection Program: Establish and implement a respirator program as required by ANSI 288.2 and 29 CFR 1910.134. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.
   a. Respirator Program Records: Submit records of the respirator program as required by ANSI 288.2 and 29 CFR 1910.134.
7. Contractor/Supervisor (Asbestos Abatement): The Contractor shall be represented on-site by a trained contractor/Supervisor. This person shall be on-site at all times when asbestos work is in progress. The Qualified Person, as defined herein, can be the Contractor/Supervisor.
8. Hazard Communication: Adhere to all parts of 29 CFR 1910.1200 and 29 CFR 1926.59. Provide the Contracting Officer with a copy of the Material Safety Data Sheets (MSDS) for all materials brought to the site. Review the Asbestos Survey Report(s) provided by the ODR or UTHSCSA consultant, if any.
9. Asbestos Abatement Design Specification: Submit a detailed plan of the safety precautions such as lockout, tag-out, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan shall be prepared by the Contractor (and reviewed and signed by an asbestos consultant (LAC) licensed according to the Statutes of the State in which the work is to be performed) for review and recommendation for approval by the ODR or UTHSCSA consultant. The plan shall be forwarded to the ODR or UTHSCSA consultant for final approval at least 10 days before beginning abatement activities. The plan shall include but not be limited to the detailed description of personal protective equipment and work practices to be used including, but not limited to, respiratory protection, type of whole-body protection, the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, the interface of trades involved in the construction, sequencing of asbestos-related work, disposal plan, type of wetting agent and asbestos encapsulant to be used, locations

of local exhaust equipment, planned air sampling strategies, and a detailed description of the method to be employed to control environmental pollution. The plan shall also include both fire and medical emergency response plans. The Asbestos Hazard Abatement Plan must be approved in writing before starting any asbestos work.

10. Testing Laboratory: Submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and/or permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) or successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis.
11. Landfill Approval: Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA and State and local regulatory agency(s).
12. Asbestos Waste Manifest: UT Health is to receive a waste manifest signed by the on-site UT Health representative, the abatement contractor, and the landfill.
13. Negative Exposure Assessment: Submit objective data demonstrating that the method(s) used for the specified non-friable ACM removal does not release airborne concentrations of asbestos fibers exceeding the TWA PEL or excursion limit. This data may be from previous work within the last 12 months or from initial exposure assessments on this project. Data from previous work must have been gathered by the firm employed on this contract, using workers trained to the same level, with the ACM and workplace conditions "closely resembling" the conditions for this contract.
14. Contractor Daily Reports: Prepare a written report for each day that asbestos work is being accomplished. The report should be submitted to the ODR or UTHSCSA consultant monthly. The report as a minimum shall include the following, where applicable:
    a. Daily Visual Inspection Reports: Prepare a written report documenting compliance with the Asbestos Hazard Abatement Plan and Federal, State, or local regulations.
    b. Air Sampling Reports: If lab work is conducted on-site, then complete fiber counting within 24 hours of the "time off" of the sample pump. If lab work is conducted off-site, the sampling report is due within 72 hours. Notify the UT Health Project Manager immediately of any airborne levels of asbestos fibers over the acceptable limits. Sampling results shall be submitted to the UT Health Project Manager. The affected employees will be provided copies of the results where required by law within 3 working days. These results shall be signed by the air sampler and the testing laboratory employee that analyzed the sample.
    c. Pressure Differential Recordings for Local Exhaust System-Not Used
    d. Asbestos Disposal Quantity Report: The Contractor shall record and report daily the amount of asbestos-containing material removed and the amount transported for disposal. Deliver the report for the previous day and cumulative totals with amounts of material removed reported in linear meters or square meters linear feet or square feet as described initially in this specification and the amounts of material transported for disposal reported in cubic meters yards.

D. Submittals
1. Submit the following by Section "Submittal Procedures."
    a. Vacuums and tools
    b. Respirators
    c. Wetting Agent
    d. Safety Data Sheets (SDS) for all materials proposed for transport to the project site
    e. Local exhaust system
    f. Pressure differential automatic recording instrument
    g. Daily Reports
    h. Asbestos Abatement Design Specification

i. Testing laboratory
j. Training Certificates
k. Landfill approval
l. Employee training
m. Medical certification requirements
n. Asbestos waste manifesto
o. Respiratory Protection Program (The abatement contractor can decide to conduct worker exposure air monitoring during the abatement)
p. Negative Exposure Assessment
q. Local Exhaust system
r. Show compliance with ANSI Z9.2 by providing manufacturers' certifications.
s. Permits, licenses, and Notifications
t. Rental equipment
u. Respirator program records
v. Protective clothing decontamination quality control records
w. Protective clothing decontamination facility notification.

E. Quality Assurance
1. Glovebags-Not Used
2. Rental Equipment: Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.
3. Protective Clothing Decontamination Quality Control Records: Provide all records that document quality control for the decontamination of reusable outer protective clothing.
4. Protective Clothing Decontamination Facility Notification: Submit written evidence that persons who decontaminate, store, or transport asbestos-contaminated clothing used in the performance of this contract were duly notified by 29 CFR 1926.1101.

1.2 PRODUCTS

A. Encapsulants
1. See Division 21 Section "Facility Fire-suppression Water-service Piping".

1.3 EXECUTION

A. Equipment
1. Respirators: Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH). Provide personnel engaged in pre-cleaning, cleanup, handling, and removal of asbestos-containing materials with the appropriate respiratory protection as specified in 29 CFR 1910.134.

2. Exterior Whole Body Protection:
   a. Non-Breathable Outer Protective Clothing: Not required for the removal of non-friable ACM
   b. Eye Protection: Provide goggles to personnel engaged in asbestos abatement operations when the use full-face face respirator is not required.

3. Warning Signs and Labels: Provide bilingual warning signs printed in English and Spanish at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.
   a. Warning Sign: Provide vertical format conforming to 29 CFR 1926.1101 minimum 20 by 14 inches (500 by 355 mm) displaying the following legend in the lower panel:

Legend	Notation

Danger	25 mm one inch Sans Serif Gothic or Block
Asbestos	25 mm one inch Sans Serif Gothic or Block
Cancer and Lung Disease Hazard	6 mm 1/4 inch Sans Serif Gothic or Block
Authorized Personnel only	6 mm 1/4 inch Gothic
Respirators and Protective Clothing is Required in this Area	6 mm 1/4 inch Gothic

Spacing between lines shall be at least equal to the height of the upper of any two lines.

b. Warning Labels: Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD
BREATHING ASBESTOS DUST MAY
CAUSE SERIOUS BODILY HARM

4. Vacuums and Tools: Vacuums shall be leakproof to the filter and equipped with HEPA filters. Filters on vacuums shall conform to ANSI Z9.2 and UL 586. Do not use power tools to remove asbestos-containing materials unless the tool is equipped with effective, integral HEPA-filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools before storage or reuse.

B. General

Pre-Asbestos Work Conference: The Contractor and the Project Manager/Air Monitoring Technician PM/AMT as per the TDSHS 2021 regulation shall meet with the Contracting officer before beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by UT Health Project Manager, the plan will be enforced as a part of this specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan to allow for free discussion and approval by UT Health EHS Department before starting work.

1. Asbestos Control Area Requirements: The Contractor shall demarcate the asbestos control area(s) using physical barriers and signs to prevent access by unauthorized personnel. This area is defined by 29 CFR 1926.1101 as the regulated area.
2. Work Procedure: Perform asbestos-related work by 29 CFR 1926.1101, 40 CFR 61-SUBPART M, applicable State or local regulation, and as specified herein. Use wet removal procedures. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, drinking, chewing gum or tobacco, or applying cosmetics shall not be permitted in the asbestos control area(s). Personnel of other trades not engaged in the removal of asbestos-containing material shall not be exposed at any time to airborne concentrations of asbestos. If an asbestos fiber release or spill, stop work immediately, correct and the condition to the satisfaction of The UT Health EHS Department, including clean-up and clearance sampling, if appropriate, before the resumption of work.
3. Removable objects: Removable objects will be removed from the area of work by UT Health Project Manager before asbestos work begins.
4. Pre-cleaning: Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos before the establishment of an enclosure.

C. Removal Procedures: Wet asbestos-containing material with a fine spray of amended water during removal, cutting, or another handling to reduce the emission of airborne fibers. Remove the material and immediately place it in 0.15 mm 6 mil plastic disposal bags. Gradually remove asbestos-containing material, with continuous application of the amended water in such a manner that no asbestos material is disturbed before being adequately wetted. Where unusual circumstances prohibit the use of 0.15 mm 6 mil plastic bags, submit an alternate proposal for the containment of asbestos fibers to The University's Engineer for approval. Asbestos-containing material shall be containerized while wet. At no time shall asbestos-containing material be allowed to accumulate or become dry. Handle asbestos-containing material as indicated in 40 CFR 61-SUBPART M, applicable State or local regulation, and 29 CFR 1926.1101.

1. Exposed Pipe Insulation Edges-Not Used
2. Negative Pressure Enclosure: Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos-negative pressure enclosure with the use of curtains, portable partitions, or other enclosures to prevent the escape of asbestos fibers from the contaminated asbestos work area.
    a. Personnel/Equipment Decontamination Unit: Provide a temporary facility with separate equipment/dirty change room and clean change room. Provide a shower that complies with 29 CFR 1926.51 in between the dirty room and a clean room for personnel required to wear whole-body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos-contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. All employees shall shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos-contaminated work clothing as asbestos-contaminated waste or properly decontaminate it as specified in the Asbestos Hazard Abatement Plan.
    b. Waste Load-Out Unit: Provide a separate temporary area expressly for short-term storage of bagged asbestos-containing material that is ready for disposal. The unit shall be the only port used to transfer waste to a truck, dumpster, or other approved on-site storage facility. It shall not be used for personnel egress. A waste load-out unit shall be integral to each negative pressure enclosure.
3. Non-friable Removal Procedures:
    a. Under normal conditions EPA Category II, non-friable asbestos-containing materials may not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal; therefore it must be handled in a manner to prevent the release of asbestos fibers. At no time will this material be mechanically chipped, sawed, sanded, or ground.
    b. Before to beginning removal, establish an Asbestos Control Area and install Critical Barriers as specified elsewhere in this section. Submit a Negative Exposure Assessment that is less than 12 months old to the ODR or UTHSCSA consultant for approval or conduct air sampling as specified elsewhere in this section to establish the exposure levels for the exact removal method being used. The Contractor will establish the correct level of Personal Protective Equipment required.
    c. Acceptable methods of removal include but are not limited to, the use of dry ice, a heat gun or lamp, citrus-based solvents, and hand tools with amended water. Removal shall be accomplished to keep the ACM substantially intact. Breakage into small pieces is an unacceptable work practice. The method shall be detailed in the Asbestos Abatement Plan and shall not be changed during the removal without the Contracting Officer's approval.
    d. Upon completion of the removal and clean-up, but before removal of critical barriers, the UT Health Consultant shall conduct a visual inspection of all areas affected by the removal. Re-clean as required.

D. Field Quality Control Requirements

1. Visual Inspections: The UT Health consultant will conduct periodic inspections of all areas where asbestos removal and activities are in progress to ensure compliance with the approved Asbestos Abatement Design Specification and Federal/State regulatory requirements. This inspection shall

include confirmation of proper control/containment/enclosure, worker protection, housekeeping, exhaust equipment operation, decontamination procedures, proper wetting and disposal, and inspection of work progress and work practices. Each activity will be documented as acceptable or noted as unacceptable with justification for the non-compliance.

2. Air Sampling: Sampling of airborne concentrations of asbestos fibers shall be performed by 29 CFR 1926.1101 and as specified herein. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Air Sampling may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate.

    a. Baseline Sampling - Perform State required for all asbestos abatement work areas before the beginning of abatement preparation.

    b. Sampling During Asbestos Work
        1) The UT Health Consultant shall perform area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Perform area sampling at least once every week close to the work inside the enclosure, and outside the personnel/equipment decontamination unit entrance to the enclosure.
        2) If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the fiber release, and notify the UT Health Project Manager immediately. Determine by testing if adjacent areas are contaminated. If so the Contractor shall clean the contaminated areas, visually inspect, and sample the areas as specified herein.
        3) The Contractor shall conduct personal sampling of at least 25% of the workers engaged in asbestos handling (removal, disposal, transport, and other associated work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored in the breathing zone of the workers at any time exceeds 0.1 fibers per cubic centimeter, notify the QPP immediately, evaluate work practices, and take corrective action to reduce airborne asbestos fibers.

E. Clean-Up And Disposal
1. Housekeeping
    a. Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA-filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. All asbestos waste shall be placed in an approved on-site storage facility or transported for disposal daily. When asbestos removal is complete, all asbestos waste is removed from the work site, and the final clean-up is completed, the QPP shall visually inspect the asbestos control area for cleanliness. After final clean-up and acceptable pre-clearance airborne concentrations are attained but before the local exhaust system is turned off and the negative pressure enclosure removed), remove all pre-filters on the building HVAC system and provide new pre-filters.
    b. Dispose of filters as asbestos-contaminated materials. Reestablish HVAC, mechanical, and electrical systems in proper working order.
2. Title to Materials: All waste materials, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified in applicable Federal, State, and local regulations and herein.
3. Disposal of Asbestos
    a. Collect all removed asbestos-containing material, contaminated materials, contaminated water, scrap, debris, bags, containers, expendable equipment, and asbestos-contaminated clothing which may produce airborne asbestos fibers and place them in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 0.15 mm 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet by 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each

container including the bags or use at least 0.15 mm 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag.

b. Each container or bag shall indicate that the waste generator is The University and the development at which the waste is generated, and the Job Order number of the project.

c. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to the work area enclosure) and thorough cleaning of the cargo area after the transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off The University's property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be coordinated with the UT Health Project Manager. Procedure for hauling and disposal shall comply with 40 CFR 61-SUBPART M, State, regional, and local standards. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

END OF SECTION 02 82 00 00a

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SECTION 02 84 16 00 - REMOVAL OF FLUORESCENT LIGHT BALLASTS/CAPACITORS AND FLUORESCENT LIGHT TUBES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for the removal of fluorescent light ballasts/capacitors and fluorescent light tubes. Products shall be as follows or as approved by the UT Health EHS Department. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Before the Start of Work: Submit the following to the UT Health Project Manager for review. Do not start work until these submittals are returned with the Owner's Representative's approval.
    - a. Copy of State or local license for hazardous waste hauler;
    - b. Certification of at least one on-site supervisor who has satisfactorily completed the OSHA 40-Hour Health and Safety Course for Handling Hazardous Materials;
    - c. Certificates of workers who have successfully completed at least the OSHA 40-Hour Health and Safety Course for Hazardous Materials;
    - d. List of employees scheduled to perform this work;
    - e. Schedule of start and finish times and dates for this work;
    - f. Name and address of landfill where these waste materials are to be deposited (include a contact person and telephone numbers);
    - g. Material Safety Data Sheets for all materials requiring removal;
    - h. If the contractor introduces any chemical into the work environment, a SDS for that chemical is required before use;
    - i. Transporter must have notified the EPA and/or the appropriate local government agency in advance of its intentions to transport PCB's, mercury, and cadmium, and receive an identification number pursuant to the Toxic Substance Control Act (TSCA); and
    - j. Contingency Plan for handling emergency spills or leaks.

1.2 PRODUCTS

A. Materials

1. Polyethylene Sheet: A single polyethylene film in the largest sheet size possible to minimize seams, 4.0 and 6.0 mil thick, clear, frosted, or black.
2. Duct Tape: Provide duct tape in 3" widths, witty an adhesive which is formulated to stick aggressively to sheet polyethylene.
3. Spray Cement: Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene.
4. Disposal Bays: Provide 6 mil thick leak-tight polyethylene bags.
5. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
6. **Drums:** Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA EPA (40 CFR Parts 264265 and 300), and DOT regulations (49 CFR Parts 171-178). Use of damaged drums will not be allowed.

1.3 EXECUTION

A. General
   1. Where necessary, scaffolding shall be erected to fully access all applicable fluorescent light ballasts/capacitors and tubes. At no time will the ballasts/capacitors and tubes be allowed to drop onto the floor. The contractor must take care to protect from dropping the ballasts/capacitors and fluorescent tubes.
   2. Prior to removing ballasts/capacitors and fluorescent tubes, the contractor shall ensure that all electrical service to lights has been shut off, and locked out. Temporary lighting shall be erected to adequately illuminate work areas.
   3. Depending on the height of the light fixtures, the contractor shall utilize at least a 2-person per team system. The fluorescent light tubes shall be removed and passed to the appropriate number of workers required to lower the tubes to the floor without breaking them.
   4. The worker on the floor shall lay the tubes in cardboard boxes large enough to hold a small number of tubes. Workers shall take care to not damage the tubes while they are lowered into the box. Once the box is full, it shall be wrapped with two layers of 6 mil thick polyethylene sheeting and sealed with duct tape.
   5. Contractor may choose to either remove the fluorescent light ballasts/capacitors in-place or lower the lighting fixtures for easy access. The ballasts/capacitors shall be removed from the fixtures. Electrical wiring leading from the ballasts/capacitors shall be cut away. Ballasts/capacitors shall be placed in 55-gallon drums lined with at least two 6 mil thick polyethylene bags. Be careful not to overfill the drums so that they remain manageable. Once the drums have been filled to the acceptable level, seal the lid onto the top of the drum, and affix appropriate labels. Transport drums via hand dollies.

B. Worker Protection
   1. As a minimum, while working with the ballasts/capacitors and light tubes, workers shall utilize impervious gloves adequate for the use of hazardous materials. If light ballasts/capacitors and/or light tubes are damaged, and/or exposure to these materials may reach the OSHA PEL or AGGIH threshold limit value (TLV), the contractor shall be required to provide impervious full body protection and respiratory protection. However, the contractor is required to verify the type of protection required prior to working with these materials, and have written approval by the Owner's Representative prior to beginning.
   2. In addition, workers shall not smoke, drink or eat in these areas during work activities.

C. Storage Of Fluorescent Light Ballasts/Capacitors And Light Tubes
   1. Once the containers holding the ballasts/capacitors and light tubes have been filled and sealed, they shall be stored in designated areas as agreed upon by The University Representative and Contractor. They shall not be allowed to be stored on-site in transportation vehicles until the time for them to be transported to the hazardous waste incinerators or landfill facility.

END OF SECTION 02 84 16 00

SECTION 02 85 00 00 - MOLD REMEDIATION

1.1 GENERAL

A. Description Of Work
   1. This specification covers the removal and disposal of mold. Products shall be as follows or as approved by the UT Health EHS Department. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
   1. List of all personnel to be involved in the work with their training and certifications.
   2. List of all products and procedures proposed for use in the performance of the work.
   3. Test reports.
   4. Certificates.

C. References
   1. U.S. EPA “Mold Remediation in Schools and Commercial Buildings”
   2. Texas Department of Licensing and Regulation's Mold Assessment and Remediation Rules.

D. Quality Assurance
   1. Conform to all Federal, State, and Local regulations which govern the handling and disposal of mold materials.

1.2 PRODUCT - (Not Used)

1.3 EXECUTION

A. Environmental Assessment: The presence of mold, water damage, or musty odors shall be addressed immediately. In all instances, any source(s) of water must be stopped and the extent of water damaged determined. Water damaged materials shall be dried and repaired. Mold damaged materials shall be remediated in accordance with this document.
   1. Visual Inspection: A visual inspection is the most important initial step in identifying a possible contamination problem. The extent of any water damage and mold growth shall be visually assessed. This assessment is important in determining remedial strategies. Ventilation systems shall also be visually checked, particularly for damp filters but also for damp conditions elsewhere in the system and overall cleanliness. Ceiling tiles, gypsum wallboard (sheetrock), cardboard, paper, and other cellulosic surfaces shall be given careful attention during a visual inspection. The use of equipment such as a boroscope and thermal camera to view spaces in ductwork or behind walls, or a moisture meter, to detect moisture in building materials, may be helpful in identifying hidden sources of fungal growth and the extent of water damage.
   2. Bulk/Surface Sampling
      a. Bulk or surface sampling is required to undertake a remediation. Mold is a microorganism and can only be accurately identified using a microscope.
      b. Bulk or surface samples may need to be collected to identify specific fungal contaminants as part of a medical evaluation if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is equivocal (e.g., discoloration, and staining).
      c. An individual trained in appropriate sampling methodology shall perform bulk or surface sampling. Bulk samples shall be collected from visibly moldy surfaces by scraping or cutting materials with a clean tool into a clean plastic bag. Surface samples shall be

collected by wiping a measured area with a sterile swab or by stripping the suspect surface with Zefon International manufacturer's a product called BioTape. -9+****'/;-*

d. 0Str

e. terile swabs are only used for surface sampling for viable culture analysis. They are not the preferred method for surface sampling for microscopic analysis. A laboratory specializing in mycology shall be consulted for specific sampling and delivery instructions.

3. Air Monitoring
   a. Air sampling for fungi shall not be part of a routine assessment. This is because decisions about appropriate remediation strategies can usually be made on the basis of a visual inspection. In addition, air-sampling methods for some fungi are prone to false negative results and therefore cannot be used to definitively rule out contamination.
   b. Air monitoring may be necessary if an individual(s) has been diagnosed with a disease that is or may be associated with a fungal exposure (e.g., pulmonary hemorrhage/hemosiderosis, and aspergillosis).
   c. Air monitoring may be necessary if there is evidence from a visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building. It is preferable to conduct sampling while ventilation systems are operating.
   d. Air monitoring may be necessary if the presence of mold is suspected (e.g., musty odors) but cannot be identified by a visual inspection or bulk sampling (e.g., mold growth behind walls). The purpose of such air monitoring is to determine the location and/or extent of contamination.
   e. If air monitoring is performed, for comparative purposes, outdoor air samples shall be collected concurrently at an air intake, if possible, and at a location representative of outdoor air. For additional information on air sampling, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."
   f. Personnel conducting the sampling shall be trained in proper air sampling methods for microbial contaminants. A laboratory specializing in mycology shall be consulted for specific sampling and shipping instructions. The person conducting the air sampling and the lab performing the analysis must both be licensed entities.

4. Analysis of Environmental Samples
   a. Microscopic identification of the spores/colonies requires considerable expertise. These services are not routinely available from commercial laboratories. Documented quality control in the laboratories used for analysis of the bulk/surface and air samples is necessary. The American Industrial Hygiene Association (AIHA) offers accreditation to microbial laboratories (Environmental Microbiology Laboratory Accreditation Program (EMLAP)). Accredited laboratories must participate in quarterly proficiency testing (Environmental Microbiology Proficiency Analytical Testing Program (EMPAT)).

5. Evaluation of bulk/surface and air sampling data shall be performed by an experienced health professional. The presence of few or trace amounts of fungal spores in bulk/surface sampling shall be considered background. Amounts greater than this or the presence of fungal fragments (e.g., hyphae, and conidiophores) may suggest fungal colonization, growth, and/or accumulation at or near the sampled location. Air samples shall be evaluated by means of comparison (i.e., indoors to outdoors) and by fungal type (e.g., genera, and species). In general, the levels and types of fungi found should be similar indoors (in non-problem buildings) as compared to the outdoor air. Differences in the levels or types of fungi found in air samples may indicate that moisture sources and resultant fungal growth may be problematic.

B. Remediation

1. 6+3General
   a. **In all situations, the underlying cause of water accumulation must be rectified or fungal growth will recur.** Any initial water infiltration shall be stopped and cleaned immediately. An immediate response (within 24 to 48 hours) and thorough clean up,

drying, and/or removal of water-damaged materials will prevent or limit mold growth. If the source of water is elevated humidity, relative humidity shall be maintained at levels below 60% to inhibit mold growth. Emphasis shall be on ensuring proper repairs of the building infrastructure so that water damage and moisture buildup do not recur.

b. Five different levels of remediation are described below. The size of the area impacted by fungal contamination primarily determines the type of remediation. The sizing levels below are based on professional judgment and practicality; currently, there is not adequate data to relate the extent of contamination to the frequency or severity of health effects. **The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.** The listed remediation methods were designed to achieve this goal, however, due to the general nature of these methods, it is the responsibility of the people conducting remediation to ensure the methods enacted are adequate. The listed remediation methods are not meant to exclude other similarly effective methods. Any changes to the remediation methods listed in these guidelines, however, shall be carefully considered prior to implementation.

c. Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are structurally sound and are visibly moldy can be cleaned and reused. Cleaning shall be done using a detergent solution. Surface cleaning should always be the following two-step procedure: 1 - HEPA vacuum clean; 2 - surface wipe using an EPA-registered sanitizer using microfiber clothes. Porous materials such as ceiling tiles and insulation, and wallboards with more than a small area of contamination shall be removed and discarded. Porous materials (e.g., wallboard, and fabrics) that can be cleaned, can be reused, but should be discarded if possible. A Licensed Mold Assessment Consultant shall be contacted when restoring porous materials with more than a small area of fungal contamination. All materials to be reused shall be dry and visibly free from mold. Routine inspections shall be conducted to confirm the effectiveness of remediation work.

d. The use of gaseous, vapor-phase, or aerosolized biocides for remedial purposes is **not** recommended. The use of biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space if used improperly. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mold. For additional information on the use of biocides for remedial purposes, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."

2. ***Level I***: **Small Isolated Areas** (10 sq. ft or less) - e.g., ceiling tiles, small areas on walls

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons recovering from recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).

d. Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.

e. Contaminated materials that cannot be cleaned shall be removed from the building in a sealed plastic bag. There are no special requirements for the disposal of moldy materials.

f. The work area and areas used by remedial workers for egress shall be cleaned with a damp cloth and/or mop and a detergent solution.

g. All areas shall be left dry and visibly free from contamination and debris.

3. ***Level II*: Mid-Sized Isolated Areas** (10 - 30 sq. ft.) - e.g., individual wallboard panels. **NOTE: The Texas Mold Rules require areas of mold contamination that are 25 or more square feet to be remediated by licensed individuals in a negative air pressure enclosure.**

a. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

b. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).

c. The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.

d. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.

e. Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.

f. The work area and areas used by remedial workers for egress shall be HEPA vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) and cleaned with a damp cloth and/or mop and a detergent solution.

g. All areas shall be left dry and visibly free from contamination and debris.

4. ***Level III*: Large Isolated Areas** (30 - 100 square feet) - e.g., several wallboard panels.

a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project.

b. The following procedures *at a minimum* are recommended:

1) Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

2) The work area and areas directly adjacent shall be covered with a plastic sheet(s) and taped before remediation, to contain dust/debris.

3) Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.

4) The work area and areas directly adjacent shall be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).

5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.

6) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.

7) The work area and surrounding areas shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.

8) All areas shall be left dry and visibly free from contamination and debris.

c. If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level IV are followed.

5. ***Level IV*: Extensive Contamination** (greater than 100 contiguous square feet in an area)

    a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project. The following procedures are recommended:
        1) Personnel trained in the handling of hazardous materials equipped with:
            a) Full-face respirators with high efficiency particulate air (HEPA) cartridges
            b) Disposable protective clothing covering both head and shoes
            c) Gloves
        2) Containment of the affected area:
            a) Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
            b) The use of an exhaust fan with a HEPA filter to generate negative pressurization
            c) Airlocks and decontamination room
        3) Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
        4) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. The outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
        5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop with a detergent solution and be visibly clean prior to the removal of isolation barriers.
        6) Air monitoring shall be conducted prior to occupancy to determine if the area is fit to reoccupy.

6. ***Level V***: Remediation of HVAC Systems

    a. A Small Isolated Area of Contamination (<10 square feet) in the HVAC System
        1) Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
        2) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
        3) The HVAC system shall be shut down prior to any remedial activities.
        4) The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
        5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
        6) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned shall be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.

7) The work area and areas immediately surrounding the work area shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
8) All areas shall be left dry and visibly free from contamination and debris.
9) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.

b. Areas of Contamination (>10 square feet) in the HVAC System: A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:

1) Personnel trained in the handling of hazardous materials equipped with:
    a) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended.
    b) Gloves and eye protection
    c) Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes shall be worn if contamination is greater than 30 square feet.
2) The HVAC system shall be shut down prior to any remedial activities.
3) Containment of the affected area:
    a) Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.
    b) The use of an exhaust fan with a HEPA filter to generate negative pressurization.
    c) Airlocks and decontamination room if contamination is greater than 30 square feet.
4) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.
6) All areas shall be left dry and visibly free from contamination and debris.
7) Air monitoring shall be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.
8) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.

7. Hazard Communication: When fungal growth requiring large-scale remediation is found, the building owner, management, and/or employer shall notify occupants in the affected area(s) of its presence. Notification shall include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to bioaerosol exposure should see their physicians for a referral to practitioners who are trained in occupational/environmental medicine or related specialties and are knowledgeable about these types of exposures. Individuals seeking medical attention shall be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

END OF SECTION 02 85 00 00

SECTION 03 01 30 71 - REHABILITATION OF CAST-IN-PLACE CONCRETE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for concrete rehabilitation. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Removal of deteriorated concrete and reinforcement and subsequent replacement and patching.
      b. Floor joint repair.
      c. Epoxy crack injection.
      d. Corrosion-inhibiting treatment.
      e. Polymer overlays.
      f. Polymer sealers.
      g. Steel structural reinforcement.
      h. Composite structural reinforcement.

C. Submittals
   1. Product Data: For each type of product indicated. Include material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.
   2. Formwork and Shoring Drawings: Prepared by or under the supervision of a qualified professional engineer detailing formwork and temporary shoring and supports. Include schedule and sequence for erection and removal relative to removal of deteriorated concrete and reinforcement and subsequent repair and reinforcement.
   3. Samples: Cured Samples of overlay and patching materials.
   4. Rehabilitation Program: For each phase of rehabilitation process, including protection of surrounding materials and Project site during operations. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.
      a. If alternative materials and methods to those indicated are proposed for any phase of rehabilitation work, submit substitution request and provide a written description of proposed materials and methods, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.

D. Delivery, Storage, And Handling
   1. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with type and name of products and manufacturers.
   2. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
   3. Store cementitious materials off the ground, under cover, and in a dry location.
   4. Store aggregates, covered and in a dry location, where grading and other required characteristics can be maintained and contamination avoided.

E. Project Conditions
   1. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

a. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40 deg F (5 deg C) within 8 hours.
b. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60 deg F (16 deg C) within 8 hours.
c. Use only Class C epoxies when substrate temperatures are above and are expected to stay above 60 deg F (16 deg C) for 8 hours.

2. Cold-Weather Requirements for Cementitious Materials:
   a. Do not apply unless air temperature is above 40 deg F (5 deg C) and will remain so for at least 48 hours after completion of Work.
      OR
      Comply with the following procedures:
      1) When air temperature is below 40 deg F (5 deg C), heat patching material ingredients and existing concrete to produce temperatures between 40 and 90 deg F (5 and 32 deg C).
      2) When mean daily air temperature is between 25 and 40 deg F (minus 4 and plus 5 deg C), cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
      3) When mean daily air temperature is below 25 deg F (minus 4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
3. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F (32 deg C) and above.
4. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below 55 deg F (13 deg C) or above 75 deg F (24 deg C) **OR** 90 deg F (32 deg C), **as directed**. Apply only to dry substrates **OR** substrates that have been dry for at least 72 hours.

1.2 PRODUCTS

A. Bonding Agents
1. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.
2. Epoxy Bonding Agent: ASTM C 881/C 881M, Type II **OR** V, **as directed**.
   a. Thin Film Open Time: Not less than two **OR** six **OR** 24, **as directed**, hours.
3. Latex Bonding Agent: ASTM C 1059, Type I **OR** II **OR** II at exterior locations and where indicated, Type I at other locations, **as directed**.
4. Mortar Scrub-Coat: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 1 part fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.

B. Patching Mortar
1. Patching Mortar, General:
   a. Overhead Patching Mortar: For overhead repairs, use patching mortar recommended by manufacturer for overhead use and as specified in this Article.
   b. Coarse Aggregate for Adding to Patching Mortar: Washed aggregate complying with ASTM C 33, Size No. 8, Class 5S. Add only as permitted by patching mortar manufacturer.
2. Job-Mixed Patching Mortar: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 2-1/2 parts fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.
3. Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928.

4. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.
5. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains silica fume complying with ASTM C 1240 and a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

C. Concrete
1. Concrete Materials and Admixtures: Comply with Division 03 Section "Cast-in-place Concrete".
2. Steel and Fiber Reinforcement and Reinforcement Accessories: Comply with Division 03 Section "Cast-in-place Concrete".
3. Form-Facing Materials: Comply with Division 03 Section "Cast-in-place Concrete".
4. Shotcrete: Comply with Division 03 Section "Shotcrete".
5. Preplaced Aggregate: Washed aggregate complying with ASTM C 33, Class 5S, with 95 to 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, 0 to 10 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch ((9.5-mm)) sieve **OR** 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 95 to 100 percent passing a 1-inch (25-mm) sieve, 40 to 80 percent passing a 3/4-inch (19-mm) sieve, 0 to 15 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch (9.5-mm) sieve, **as directed**.
6. Fine Aggregate for Grout Used with Preplaced Aggregate: Fine aggregate complying with ASTM C 33, but with 100 percent passing a No. 8 (2.36-mm) sieve, 95 to 100 percent passing a No. 16 (1.18-mm) sieve, 55 to 80 percent passing a No. 30 (0.6-mm) sieve, 30 to 55 percent passing a No. 50 (0.3-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, 0 to 10 percent passing a No. 200 (0.075-mm) sieve, and having a fineness modulus of 1.30 to 2.10.
7. Grout Fluidifier for Grout Used with Preplaced Aggregate: ASTM C 937.
8. Portland Cement for Grout Used with Preplaced Aggregate: ASTM C 150.
9. Pozzolans for Grout Used with Preplaced Aggregate: ASTM C 618.

D. Miscellaneous Materials
1. Epoxy Joint Filler: 2-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
2. Polyurea Joint Filler: 2-component, semirigid, 100 percent solids, polyurea resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
3. Epoxy Crack Injection Adhesive: ASTM C 881/C 881M, Type I **OR** IV, **as directed**, Grade 1, except for gel time **OR** solvent free, **as directed**.
4. Capping Adhesive: Product manufactured for use with crack injection adhesive by same manufacturer.
5. Corrosion-Inhibiting Treatment Materials: Water-based solution of alkaline corrosion-inhibiting chemicals that penetrates concrete by diffusion and forms a protective film on steel reinforcement.
6. Polymer Overlay: Epoxy adhesive complying with ASTM C 881/C 881M, Type III.
7. Aggregate for Use with Polymer Overlay: Oven-dried, washed silica sand complying with ACI 503.3.
8. Polymer Sealer: Low-viscosity epoxy or high-molecular-weight methacrylate penetrating sealer recommended by manufacturer for application to exterior concrete traffic surfaces.
9. Methylmethacrylate Sealer/Brighteners: Clear low-viscosity sealer recommended by manufacturer for sealing exterior exposed-aggregate concrete, and formulated to bring out color of aggregates and give concrete a wet look.
10. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
    a. After fabricating, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    b. For minimum protection to steel after preparation, apply one coat of lead- and chromate-free, modified-alkyd primer complying with MPI#76 and one coat of alkyd-gloss enamel complying with MPI#96.

c. After preparation, apply two-coat high-performance coating system consisting of organic zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and topcoat of high-build, urethane or epoxy coating recommended by manufacturer for application over specified zinc-rich primer. Comply with coating manufacturer's written directions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

11. Bolts, Nuts, and Washers: Carbon steel; ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), for bolts; ASTM A 563 (ASTM A 563M), Grade A, for nuts; and ASTM F 436 (ASTM F 436M) for washers; hot-dip or mechanically zinc coated.
12. Postinstalled Anchors: Chemical or expansion anchors, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
13. Composite Structural Reinforcement: Manufacturer's system consisting of carbon **OR** glass, **as directed**,-fiber reinforcement in the form of preimpregnated sheets or tow sheet with field-applied saturant, and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as external structural reinforcement for concrete.

E. Mixes

1. Mix products, in clean containers, according to manufacturer's written instructions.
   a. Add clean silica sand and coarse aggregates to products only as recommended by manufacturer.
   b. Do not add water, thinners, or additives unless recommended by manufacturer.
   c. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
   d. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.
2. Mortar Scrub-Coat: Mix with enough water to provide consistency of thick cream.
3. Dry-Pack Mortar: Mix with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.
4. Concrete: Comply with Division 03 Section "Cast-in-place Concrete".
5. Shotcrete: Comply with Division 03 Section "Shotcrete".
6. Grout for Use with Preplaced Aggregate: Proportion according to ASTM C 938. Add grout fluidifier to mixing water followed by cementitious materials and then fine aggregate.

1.3 EXECUTION

A. Examination

1. Notify UT Health seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.
2. Locate areas of deteriorated or delaminated concrete using hammer or chain drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb, unless otherwise indicated.
3. Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer, using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

B. Preparation

1. Protect people, motor vehicles, equipment, surrounding construction, Project site, plants, and surrounding buildings from injury resulting from concrete rehabilitation work.

    a. Erect and maintain temporary protective covers over pedestrian walkways and at points of entrance and exit for people and vehicles, unless such areas are made inaccessible during the course of concrete rehabilitation work. Construct covers of tightly fitted, 3/4-inch (19-mm) exterior-grade plywood supported at 16 inches (405 mm) o.c. and covered with asphalt roll roofing.
    b. Protect adjacent equipment and surfaces by covering them with heavy polyethylene film and waterproof masking tape or a liquid strippable masking agent. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
    c. Neutralize and collect alkaline and acid wastes according to requirements of authorities having jurisdiction, and dispose of by legal means off Owner's property.
    d. Dispose of runoff from wet operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
    e. Collect runoff from wet operations and dispose of by legal means off Owner's property.
2. Shoring: Install temporary supports before beginning concrete removal.
3. Concrete Removal:
    a. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch (13 mm). Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.
    b. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.
    c. Remove additional concrete, if necessary, to provide a depth of removal of at least 1/2 inch (13 mm) over entire removal area.
    d. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least a 3/4-inch (19-mm) clearance around bar.
    e. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
    f. Provide fractured aggregate surfaces with a profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level, unless otherwise directed.
    g. Thoroughly clean removal areas of loose concrete, dust, and debris.
4. Reinforcing Bar Preparation: Remove loose and flaking rust from reinforcing bars by high-pressure water cleaning **OR** abrasive blast cleaning **OR** needle scaling **OR** wire brushing, **as directed**, until only tightly bonded light rust remains.
    a. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in 2 or more adjacent bars, cut bars and remove and replace. Remove additional concrete as necessary to provide at least 3/4-inch (19-mm) clearance at existing and replacement bars. Splice replacement bars to existing bars according to ACI 318 (ACI 318M), by lapping, welding, or using mechanical couplings.
5. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.
6. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete by low-pressure water cleaning **OR** detergent scrubbing **OR** sand blasting, **as directed**, to remove dirt, oils, films, and other materials detrimental to treatment application. Allow surface to dry before applying corrosion-inhibiting treatment.
7. Surface Preparation for Overlays: Remove delaminated material and deteriorated concrete surface material. Roughen surface of concrete by sand blasting **OR** shot blasting **OR** scarifying **OR** needle scaling **OR** high-pressure water jetting **OR** scabbling **OR** flame blasting **OR** milling, **as directed**, to produce a surface profile matching CSP 3 **OR** 4 **OR** 5 **OR** 6 **OR** 7 **OR** 8 **OR** 9, **as directed**, per ICRI 03732. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.
8. Surface Preparation for Sealers: Clean concrete by shot blasting **OR** low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to sealer application.

9. Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 per ICRI 03732. Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.
    a. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
    b. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
    c. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable.
    d. When pH is acceptable and surface is clean, vacuum dry.
10. Surface Preparation for Composite Structural Reinforcement: Remove delaminated material and deteriorated concrete surface material. Clean concrete where reinforcement and epoxy patching mortar is to be applied by low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to epoxy application. Roughen surface of concrete by sand blasting.

C. Application
1. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.
2. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars and concrete by stiff brush or hopper spray according to manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.
3. Epoxy Bonding Agent: Apply to reinforcing bars and concrete by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat. Apply patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.
4. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface according to manufacturer's written instructions. Apply patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.
5. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.
6. Mortar Scrub-Coat: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub-coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub-coat dries, recoat before applying patching mortar or concrete.
7. Patching Mortar: Unless otherwise recommended by manufacturer, apply as follows:
    a. Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.
    b. Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
    c. For vertical patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
    d. For overhead patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
    e. After each lift is placed, consolidate material and screed surface.
    f. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.
    g. Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth **OR** rough, **as directed**, surface with a wood or sponge float **OR** broom or burlap drag, **as directed**.

   h. Wet-cure cementitious patching materials, including polymer-modified, cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

8. Dry-Pack Mortar: Use for deep cavities and where indicated. Unless otherwise recommended by manufacturer, apply as follows:
   a. Provide forms where necessary to confine patch to required shape.
   b. Wet substrate and forms thoroughly and then remove standing water.
   c. Place dry-pack mortar into cavity by hand, and compact into place with a hardwood drive stick and mallet or hammer. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.
   d. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.
   e. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.
9. Concrete: Place according to Division 03 Section "Cast-in-place Concrete" and as follows:
   a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
   b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
   c. Use vibrators to consolidate concrete as it is placed.
   d. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
   e. Where indicated place concrete by form and pump method.
      1) Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and junctions of forms with existing concrete.
      2) Pump concrete into place, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi (96 kPa).
   f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
   g. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.
10. Shotcrete: Place according to Division 03 Section "Shotcrete" and as follows:
   a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
   b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
   c. Screed and finish shotcrete to produce a surface matching required profile and surrounding concrete.
11. Grouted Preplaced Aggregate Concrete: Use for column and wall repairs **OR** where indicated, **as directed**. Place as follows:
   a. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and junctions of forms with existing concrete.
   b. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
   c. Place aggregate in forms, consolidating aggregate as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.
   d. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.
   e. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to 14 psi (96 kPa).
   f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

    g. Repair voids with patching mortar and finish to match surrounding concrete.
12. Joint Filler: Install in nonmoving floor joints where indicated.
    a. Install filler to a depth of at least 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**. Use fine silica sand no more than 1/4 inch (6 mm) deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.
    b. Install filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.
13. Epoxy Crack Injection: Comply with manufacturer's written instructions and the following:
    a. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond, and clean cracks with oil-free compressed air or low-pressure water to remove loose particles.
    b. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.
    c. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch (6 mm) thick by 1 inch (25 mm) wider than crack.
    d. Inject cracks wider than 0.003 inch (0.075 mm) to a depth of 8 inches (200 mm) or to a width of less than 0.003 inch (0.075 mm), whichever is less.
    e. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.
    f. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.
14. Corrosion-Inhibiting Treatment: Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete or applying a sealer or overlay.
15. Polymer Overlay: Apply according to ACI 503.3.
    a. Apply to traffic-bearing surfaces, including parking areas and walks.
16. Polymer Sealer: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
    a. Apply to traffic-bearing surfaces, including parking areas and walks.
17. Methylmethacrylate Sealer/Brighteners: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
    a. Apply to exterior concrete surfaces that are exposed to view, excluding traffic-bearing surfaces.
18. Composite Structural Reinforcement Using Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, apply as follows:
    a. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
    b. Apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm) to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
    c. Clean preimpregnated fiber sheet with acetone or other suitable solvent, and apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm).
    d. Apply adhesive-coated fiber sheet to adhesive-coated concrete within open time of epoxy adhesive, and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
    e. Apply additional layers as indicated using same procedure.
19. Composite Structural Reinforcement Using Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, apply as follows:
    a. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
    b. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
    c. Apply epoxy saturant to fiber tow sheet or primed and patched surface with 3/8-inch- (10-mm-) nap roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy as needed to fully saturate tow sheet.

- d. Apply additional layers as indicated, fully saturating each with epoxy.
- e. After saturant has cured, apply protective topcoat by brush, roller or spray.

D. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to sample materials and perform tests as follows:
   - a. Patching Mortar, Packaged Mixes: <**Insert number**> randomly selected samples tested according to ASTM C 928.
   - b. Patching Mortar, Field Mixed: <**Insert number**> randomly selected samples tested for compressive strength according to ASTM C 109/C 109M.
   - c. Concrete: As specified in Division 03 Section "Cast-in-place Concrete".
   - d. Shotcrete: As specified in Division 03 Section "Shotcrete".
   - e. Grouted Preplaced Aggregate: Tested for compressive strength of grout according to ASTM C 942.
     - 1) Testing Frequency: One sample for each 25 cu. yd. (19 cu. m) of grout or fraction thereof, but not less than one sample for each day's work.
   - f. Joint Filler: Core drilled samples to verify proper installation.
     - 1) Testing Frequency: One sample for each 100 feet (30 m) of joint filled.
     - 2) Where samples are taken, fill holes with joint filler.
   - g. Epoxy Crack Injection: Core drilled samples to verify proper installation.
     - 1) Testing Frequency: 3 samples from mockup and 1 sample for each 100 feet (30 m) of crack injected.
     - 2) Where samples are taken, fill holes with epoxy mortar.

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SECTION 03 30 00 00 - CAST-IN-PLACE CONCRETE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for cast-in-place concrete. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
      a. Footings.
      b. Foundation walls.
      c. Slabs-on-grade.
      d. Suspended slabs.
      e. Concrete toppings.
      f. Building frame members.
      g. Building walls.

C. Definitions
   1. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

D. Submittals
   1. Product Data: For each type of product indicated.
   2. Design Mixtures: For each concrete mixture.
   3. Shop Drawings: For steel reinforcement and formwork. Material test reports **OR** certificates, **as directed**.

E. Quality Assurance
   1. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
      a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
   2. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, **as directed**, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   3. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
      a. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 **OR** Sections 1 through 5 and Section 7, "Lightweight Concrete", **as directed**.
      b. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
   4. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
   5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
   1. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement, **as directed**.
   2. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.2 PRODUCTS

A. Form-Facing Materials

1. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
2. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
3. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
4. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
5. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
6. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
7. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
8. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
    a. Formulate form-release agent with rust inhibitor for steel form-facing materials.
9. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
    a. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
    b. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
    c. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

B. Steel Reinforcement

1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
4. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class I **OR** II, **as directed**, zinc coated after fabrication and bending.
5. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M **OR** ASTM A 934/A 934M, **as directed**, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
6. Stainless-Steel Reinforcing Bars: ASTM A 955/A 955M, Grade 60 (Grade 420), Type 304 **OR** 316L, **as directed**, deformed.
7. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, assembled with clips.
8. Plain-Steel Wire: ASTM A 82, as drawn **OR** galvanized, **as directed**.
9. Deformed-Steel Wire: ASTM A 496.
10. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain-steel-wire **OR** deformed-steel wire, **as directed**, with less than 2 percent damaged coating in each 12-inch (300-mm) wire length.
11. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.
12. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

13. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from galvanized steel wire into flat sheets.
14. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain **OR** deformed, **as directed**, steel.

C. Reinforcement Accessories
1. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut bars true to length with ends square and free of burrs.
2. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, ASTM A 775/A 775M epoxy coated.
3. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
4. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
5. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
    a. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
    b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
    c. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

D. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
    a. Portland Cement: ASTM C 150, Type I **OR** II **OR** I/II **OR** III **OR** V, **as directed**, gray **OR** white, **as directed**. Supplement with the following:
        1) Fly Ash: ASTM C 618, Class C **OR** F, **as directed**.
        2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
    b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** IP, portland-pozzolan **OR** I (PM), pozzolan-modified portland **OR** I (SM), slag-modified Portland, **as directed**, cement.
2. Silica Fume: ASTM C 1240, amorphous silica.
3. Normal-Weight Aggregates: ASTM C 33, graded, 1-1/2-inch (38-mm) **OR** 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum coarse-aggregate size.
    a. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
4. Lightweight Aggregate: ASTM C 330, 1-inch (25-mm) **OR** 3/4-inch (19-mm) **OR** 1/2-inch (13-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal maximum aggregate size.
5. Water: ASTM C 94/C 94M and potable, **as directed**.

E. Admixtures
1. Air-Entraining Admixture: ASTM C 260.
2. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
    a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
    b. Retarding Admixture: ASTM C 494/C 494M, Type B.
    c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
    d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
    e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
    f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
3. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing

chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

4. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
5. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.
   a. Color: As indicated by manufacturer's designation **OR** Match UTHSCSA's sample **OR** As selected by UTHSCSA from manufacturer's full range, **as directed**.

F. Fiber Reinforcement

1. Carbon-Steel Fiber: ASTM A 820, deformed, minimum of 1.5 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2.4 inches (60 mm), **as directed**, long, and aspect ratio of 35 to 40 **OR** 45 to 50 **OR** 60 to 65, **as directed**.
   a. Fiber: Type 1, cold-drawn wire **OR** 2, cut sheet, **as directed**.
2. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

G. Waterstops

1. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
   b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
2. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.
   a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
   b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/16 inch thick (150 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/16 inch thick (225 mm by 4.75 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
3. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
   b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
4. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).
5. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).

H. Vapor Retarders

1. Plastic Vapor Retarder:

a. ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
b. ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.
c. ASTM E 1745, Class C, or polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick, **as directed**. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

2. Bituminous Vapor Retarder: 110-mil- (2.8-mm-) thick, semiflexible, 7-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories including bonding asphalt, pointing mastics, and self-adhering joint tape.
   a. Water-Vapor Permeance: 0.00 grains/h x sq. ft. x inches Hg (0.00 ng/Pa x s x sq. m); ASTM E 154.
   b. Tensile Strength: 140 lbf/in. (24.5 kN/m); ASTM E 154.
   c. Puncture Resistance: 90 lbf (400N); ASTM E 154.
3. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
4. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch (9.5-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and at least 5 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

I. Floor And Slab Treatments
1. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing 3/8-inch (9.5-mm) **OR** No. 4 (4.75-mm) **OR** No. 8 (2.36-mm), **as directed**, sieve.
2. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
3. Emery Dry-Shake Floor Hardener: Pigmented **OR** Unpigmented, **as directed**, factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.
   a. Color: As indicated by manufacturer's designation **OR** Match UTHSCSA's sample **OR** As selected by UTHSCSA from manufacturer's full range, **as directed**.
4. Metallic Dry-Shake Floor Hardener: Pigmented **OR** Unpigmented, **as directed**, factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.
   a. Color: As indicated by manufacturer's designation **OR** Match UTHSCSA's sample **OR** As selected by UTHSCSA from manufacturer's full range, **as directed**.
5. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.
6. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
   a. Color: As indicated by manufacturer's designation **OR** Match UTHSCSA's sample **OR** As selected by UTHSCSA from manufacturer's full range, **as directed**.
7. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

J. Curing Materials

1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
6. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering, **as directed**.
7. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering, **as directed**.
8. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
9. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

K. Related Materials
1. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber **OR** ASTM D 1752, cork or self-expanding cork, **as directed**.
2. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 **OR** aromatic polyurea with a Type A shore durometer hardness range of 90 to 95, **as directed**, per ASTM D 2240.
3. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
4. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
    a. Types I and II, non-load bearing **OR** IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.
5. Reglets: Fabricate reglets of not less than 0.0217-inch- (0.55-mm-) thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
6. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

L. Repair Materials
1. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
    a. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
    b. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
    c. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
    d. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.
2. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
    a. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
    b. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

- c. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
- d. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

M. Concrete Mixtures, General

1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
    - a. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
2. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent **OR** Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows, **as directed**
    - a. Fly Ash: 25 percent.
    - b. Combined Fly Ash and Pozzolan: 25 percent.
    - c. Ground Granulated Blast-Furnace Slag: 50 percent.
    - d. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
    - e. Silica Fume: 10 percent.
    - f. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
    - g. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
3. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 **OR** 0.15 **OR** 0.30 **OR** 1.00, **as directed**, percent by weight of cement.
4. Admixtures: Use admixtures according to manufacturer's written instructions.
    - a. Use water-reducing **OR** high-range water-reducing **OR** plasticizing, **as directed**, admixture in concrete, as required, for placement and workability.
    - b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
    - c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
    - d. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
5. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

N. Concrete Mixtures For Building Elements

1. Footings: Proportion normal-weight concrete mixture as follows:
    - a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
    - b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
    - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
    - d. Air Content:
        - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
        - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
2. Foundation Walls: Proportion normal-weight concrete mixture as follows:
    - a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.

  - b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
- 3. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
  - a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
    - 3) Do not allow air content of troweled finished floors to exceed 3 percent.
  - e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
  - f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
- 4. Suspended Slabs: Proportion normal-weight concrete mixture as follows:
  - a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
    - 3) Do not allow air content of troweled finished floors to exceed 3 percent.
  - e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
  - f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
- 5. Suspended Slabs: Proportion structural lightweight concrete mixture as follows:
  - a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Calculated Equilibrium Unit Weight: 115 lb/cu. ft. (1842 kg/cu. m) **OR** 110 lb/cu. ft. (1762 kg/cu. m) **OR** 105 lb/cu. ft. (1682 kg/cu. m), **as directed**, plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C 567.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:

        1) 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch (10 mm).
        2) 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch (10 mm) or less.
        3) Do not allow air content of troweled finished floors to exceed 3 percent.
    e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
    f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.

6. Concrete Toppings: Proportion normal-weight concrete mixture as follows:
    a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
    b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
    c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
    d. Air Content:
        1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
        2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
        3) Do not allow air content of troweled finished toppings to exceed 3 percent.
    e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
    f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.

7. Building Frame Members: Proportion normal-weight concrete mixture as follows:
    a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
    b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
    c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
    d. Air Content:
        1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
        2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.

8. Building Walls: Proportion normal-weight concrete mixture as follows:
    a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
    b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
    c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
    d. Air Content:
        1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
        2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.

O. Fabricating Reinforcement

1. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

P. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, **as directed**, and furnish batch ticket information.
    a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
    a. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
    b. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
    c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

1.3 EXECUTION

A. Formwork
1. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
2. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
3. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
    a. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.
    b. Class B, 1/4 inch (6 mm) **OR** Class C, 1/2 inch (13 mm) **OR** Class D, 1 inch (25 mm), **as directed**, for rough-formed finished surfaces.
4. Construct forms tight enough to prevent loss of concrete mortar.
5. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
    a. Install keyways, reglets, recesses, and the like, for easy removal.
    b. Do not use rust-stained steel form-facing material.
6. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
7. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
8. Chamfer **OR** Do not chamfer, **as directed**, exterior corners and edges of permanently exposed concrete.
9. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
10. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
11. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
12. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

B. Embedded Items

1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    a. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
    b. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
    c. Install dovetail anchor slots in concrete structures as indicated.

C. Removing And Reusing Forms
1. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
    a. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of, **as directed**, its 28-day design compressive strength.
    b. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
3. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by UTHSCSA.

D. Shores And Reshores
1. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.
    a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
2. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
3. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

E. Vapor Retarders
1. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
    a. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
2. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.
3. Granular Course: Cover vapor retarder with granular fill **OR** fine-graded granular material, **as directed**, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).
    a. Place and compact a 1/2-inch- (13-mm-) thick layer of fine-graded granular material over granular fill.

F. Steel Reinforcement
1. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
    a. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

3. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
    a. Weld reinforcing bars according to AWS D1.4, where indicated.
4. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
5. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
6. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.
7. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

G. Joints
1. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by UTHSCSA.
    a. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
    b. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
    c. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
    d. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
    e. Space vertical joints in walls, **as directed**. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
    f. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
    g. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
3. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
    a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
    b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
4. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
    a. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
    b. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants", are indicated.
    c. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

H. Waterstops

1. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.
2. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

I. Concrete Placement

1. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not add water to concrete during delivery, at Project site, or during placement unless approved by UTHSCSA.
3. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
    a. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
4. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
    a. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
    b. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
    c. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
5. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
    a. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
    b. Maintain reinforcement in position on chairs during concrete placement.
    c. Screed slab surfaces with a straightedge and strike off to correct elevations.
    d. Slope surfaces uniformly to drains where required.
    e. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
6. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
    a. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
    b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
    c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
7. Hot-Weather Placement: Comply with ACI 301 and as follows:
    a. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

J. Finishing Formed Surfaces

1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   a. Apply to concrete surfaces not exposed to public view.
2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   a. Apply to concrete surfaces exposed to public view, **OR** to receive a rubbed finish, **OR** to be covered with a coating or covering material applied directly to concrete, **as directed**.
3. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
   a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
   b. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
   c. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
4. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

K. Finishing Floors And Slabs

1. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
2. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in 1 direction.
   a. Apply scratch finish to surfaces indicated and to receive concrete floor toppings **OR** to receive mortar setting beds for bonded cementitious floor finishes, **as directed**.
3. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   a. Apply float finish to surfaces indicated **OR** to receive trowel finish **OR** to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo, **as directed**.
4. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   a. Apply a trowel finish to surfaces indicated **OR** exposed to view **OR** to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system, **as directed**.

- b. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
  - 1) Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
  - 2) Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
  - 3) Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
  - 4) Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.
- c. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- (3.05-m-) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch (6 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/8 inch (3.2 mm), **as directed**.

5. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated **OR** where ceramic or quarry tile is to be installed by either thickset or thin-set method, **as directed**. While concrete is still plastic, slightly scarify surface with a fine broom.
   - a. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
6. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   - a. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with UTHSCSA before application.
7. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate **OR** aluminum granule, **as directed**, finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
   - a. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) of dampened slip-resistive aggregate **OR** aluminum granules, **as directed**, over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
   - b. After broadcasting and tamping, apply float finish.
   - c. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate **OR** aluminum granules, **as directed**.
8. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:
   - a. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m), **as directed**, unless greater amount is recommended by manufacturer.
   - b. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
   - c. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

L. Miscellaneous Concrete Items
1. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
2. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
3. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

4. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

M. Concrete Protecting And Curing
1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
2. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
3. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
4. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
5. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      1) Water.
      2) Continuous water-fog spray.
      3) Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
   b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
      1) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
      2) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
      3) Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
   c. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
      1) After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
   d. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

N. Liquid Floor Treatments
1. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   a. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.

   b. Do not apply to concrete that is less than three **OR** seven **OR** 14 **OR** 28, **as directed**, days' old.
   c. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
2. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

O. Joint Filling
1. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   a. Defer joint filling until concrete has aged at least one **OR** six, **as directed**, month(s). Do not fill joints until construction traffic has permanently ceased.
2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

P. Concrete Surface Repairs
1. Defective Concrete: Repair and patch defective areas when approved by UTHSCSA. Remove and replace concrete that cannot be repaired and patched to UTHSCSA's approval.
2. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
3. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   a. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete, but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   b. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   c. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by UTHSCSA.
4. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   a. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   b. After concrete has cured at least 14 days, correct high areas by grinding.
   c. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   d. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   e. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor

elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

- f. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- g. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

5. Perform structural repairs of concrete, subject to UTHSCSA's approval, using epoxy adhesive and patching mortar.
6. Repair materials and installation not specified above may be used, subject to UTHSCSA's approval.

Q. Field Quality Control

1. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
2. Inspections:
    - a. Steel reinforcement placement.
    - b. Steel reinforcement welding.
    - c. Headed bolts and studs.
    - d. Verification of use of required design mixture.
    - e. Concrete placement, including conveying and depositing.
    - f. Curing procedures and maintenance of curing temperature.
    - g. Verification of concrete strength before removal of shores and forms from beams and slabs.
3. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
    - a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
        - 1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
    - b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
    - c. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete, **as directed**; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    - d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
    - e. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    - f. Compression Test Specimens: ASTM C 31/C 31M.
        - 1) Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
        - 2) Cast and field cure two sets of two standard cylinder specimens for each composite sample.

g. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    1) Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    2) A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

h. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

i. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

j. Test results shall be reported in writing to UTHSCSA, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

k. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by UTHSCSA but will not be used as sole basis for approval or rejection of concrete.

l. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as approved by UTHSCSA. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as approved by UTHSCSA.

m. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

n. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

4. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 24 **OR** 48, **as directed**, hours of finishing.

END OF SECTION 03 30 00 00

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SECTION 03 53 00 00 - CONCRETE FLOOR TOPPING

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for concrete floor topping. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. This Section includes the following:
    a. Emery-aggregate concrete floor topping.
    b. Iron-aggregate concrete floor topping.

C. Submittals
  1. Product Data: For each type of product indicated.
  2. Product Test Reports.
  3. Field quality-control test reports.

D. Quality Assurance
  1. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
  2. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
  1. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.
  2. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

F. Project Conditions
  1. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete floor topping performance.
    a. Place concrete floor topping only when ambient temperature and temperature of base slabs are between 50 and 86 deg F (10 and 30 deg C).
  2. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

1.2 PRODUCTS

A. Concrete Floor Toppings
  1. Emery-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded, crushed emery aggregate containing not less than 50 percent aluminum oxide, not less than 24 percent ferric oxide, and not more than 8 percent silica; portland cement or blended hydraulic cement; plasticizers; and other admixtures to which only water needs to be added at Project site.
    a. Compressive Strength (28 Days): 10,000 psi (69 MPa); ASTM C 109/C 109M.
  2. Iron-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded iron aggregate, portland cement, plasticizers, and other admixtures to which only water needs to be added at Project site.

a. Compressive Strength (28 Days): 12,000 psi (83 MPa); ASTM C 109/C 109M.

B. Curing Materials

1. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 25 percent solids content, minimum.

C. Related Materials

1. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of 80 **OR** aromatic polyurea with a Type A Shore durometer hardness range of 90 to 95, **as directed**, per ASTM D 2240.
2. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
3. Portland Cement: ASTM C 150, Type I or II.
4. Sand: ASTM C 404, fine aggregate passing No. 16 (1.18-mm) sieve.
5. Water: Potable.
6. Acrylic-Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
7. Epoxy Adhesive: ASTM C 881/C 881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

D. Mixing

1. Bonding Slurry: Mix portland cement with water to a thick paint consistency.
   OR
   Bonding Slurry: Mix 1 part portland cement and 1-1/2 **OR** 2 **OR** 2-1/2, **as directed**, parts sand with water and an acrylic-bonding agent according to manufacturer's written instructions, **as directed**, to a thick paint consistency.
2. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

1.3 EXECUTION

A. Examination

1. Examine substrates, with Installer present, for conditions affecting performance of concrete floor topping.
2. Verify that base concrete slabs comply with scratch finish requirements specified in Division 03 Section "Cast-in-place Concrete".
3. Verify that base slabs are visibly dry and free of moisture. Test for capillary moisture by the plastic sheet method according to ASTM D 4263.
4. Proceed with application only after unsatisfactory conditions have been corrected.

B. Preparation

1. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of 1/4 inch (6 mm.)
   a. Prepare and clean existing base slabs according to concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
   b. Mechanically remove contaminants from existing concrete that might impair bond of floor topping.

    c. Saw cut contraction and construction joints in existing concrete to a depth of 1/2 inch (13 mm) and fill with semirigid joint filler.
    d. To both sides of joint edges and at perimeter of existing base slab mechanically remove a 4-inch- (100-mm-) wide and 0- to 1-inch (0- to 25-mm-) deep, tapered wedge of concrete and retexture surface **OR** install concrete nails in manufacturer's recommended staggered pattern, **as directed**.
2. Install joint-filler strips where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
    a. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface, unless otherwise indicated.
    b. Terminate full-width, joint-filler strips 1/2 inch (13 mm) below topping surface where joint sealants, specified in Division 07 Section "Joint Sealants", are indicated.
    c. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

C. Floor Topping Application
1. Start floor topping application in presence of manufacturer's technical representative.
2. Monolithic Floor Topping: After textured-float finish is applied to fresh concrete of base slabs specified in Division 03 Section "Cast-in-place Concrete", place concrete floor topping while concrete is still plastic.
3. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of 1/16 to 1/8 inch (1.6 to 3 mm), without puddling. Place floor topping while slurry is still tacky.
4. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of 1/16 to 1/8 inch (1.6 to 3 mm), without puddling. Place floor topping while adhesive is still tacky.
5. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.
    a. Screed surface with a straightedge and strike off to correct elevations.
    b. Slope surfaces uniformly where indicated.
    c. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.
6. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.
        1) Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.
        2) Finish surfaces to specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15, and measure **OR** notify independent testing agency to permit measurement, **as directed**, within 24 hours according to ASTM E 1155 (ASTM E 1155M) for a randomly trafficked floor surface.
        3) Finish and measure surface so gap at any point between surface and an unleveled freestanding 10-foot- (3-m-) long straightedge, resting on 2 high spots and placed anywhere on the surface, does not exceed 1/4 inch (6 mm).
7. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by UT Health.
    a. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.
8. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete

floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

- a. Form joints in concrete floor topping over contraction joints in base slabs, unless otherwise indicated.
- b. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
- c. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than 1/2 inch (13 mm) deep.

D. Protecting And Curing

1. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.
2. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.
3. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, according to concrete floor topping manufacturer's written instructions:
    - a. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with water **OR** continuous water-fog spray **OR** absorptive cover, water saturated and kept continuously wet. Cover topping surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers, **as directed**.
    - b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    - c. Curing Compound: Apply uniformly in two coats in continuous operations by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

E. Joint Filling

1. Prepare and clean contraction joints and install semirigid joint filler, according to manufacturer's written instructions, once topping has fully cured.
2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

F. Repairs

1. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

G. Field Quality Control

1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Testing Services: Testing and inspecting of completed applications of concrete floor toppings shall take place in successive stages, in areas of extent and using methods as follows:
    - a. Sample Sets: At point of placement, a set of 3 molded-cube samples shall be taken from the topping mix for the first 1000 sq. ft. (93 sq. m), plus 1 set of samples for each subsequent 5000 sq. ft. (464 sq. m) of topping, or fraction thereof, but not less than 6 samples for each day's placement. Samples shall be tested according to ASTM C 109/C 109M for compliance with compressive-strength requirements.
    - b. Concrete floor topping shall be tested for delamination by dragging a steel chain over the surface.

        c. Concrete floor topping shall be tested for compliance with surface flatness and levelness tolerances.

3. Remove and replace applications of concrete floor topping where test results indicate that it does not comply with specified requirements.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 03 53 00 00

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SECTION 03 54 16 00 - HYDRAULIC CEMENT UNDERLAYMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.03 QUALITY ASSURANCE

A. Concrete Supplier: Regularly engaged in production of concrete floor underlayments.

B. Concrete Applicator: Regularly engaged and properly equipped for application of concrete floor underlayments, and as acceptable by aggregate manufacturer.

1.04 SUBMITTALS

A. Product Data:

1. Product data in the form of manufacturer's technical data, specifications, and installation instructions.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original undamaged packages or acceptable bulk containers.

B. Store packaged materials to protect them from elements or physical damage.

C. Do not use cement which shows indications of moisture damage, caking, or other signs of deterioration.

1.06 PROJECT CONDITIONS

A. Do not place concrete when ambient temperature is below freezing (32 degrees F, 0 degrees C).

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MATERIALS

A. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from 1 inch thick to feathered edges.

   1. Ardex, Inc. "K-15"

B. Primer: Provide manufacturer's recommended primer for each applicable substrate.

2.03 MIXING

A. Provide batch type mechanical mixer for mixing topping material at the Project Site. Equip batch mixer with a suitable charging hopper, water storage tank, and a water-measuring device. Use only mixers which are capable of mixing aggregates, cement, and water into a uniform mix within specified time, and of discharging mix without segregation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Place underlayment in accordance with manufacturer's instructions, using equipment and procedures to avoid segregation of mix and loss of air content. Deposit and screed in a continuous operation until an entire panel or section of floor area is completed. Do not vibrate or work mix except for screeding or floating.

3.02 PLACING

A. Spread topping mixture evenly over prepared base to the required elevation and strike-off. Use highway straightedge, bull float, or darby to level surface. After the topping has stiffened sufficiently to permit the operation, and water sheen has disappeared, float the surface at least twice to a uniform sandy texture. Restraighten where necessary with highway straightedge. The surface shall achieve an FF20/FL17 tolerance when tested in accordance with ASTM E 1155. Uniformly slope surface to drains.

   1. Where joints are required, construct to match and coincide with joints in base slab. Provide other joints as shown.

B. After floating, begin first trowel finish operation using power driven trowels. Continue troweling until surface is ready to receive final troweling. Begin final troweling when a ringing sound is produce as trowel is moved over surface.

C. Continue final trowel operation to produce finished surface free of trowel marks, uniform in texture and appearance, achieving an F_F25/F_L20 when tested in accordance with ASTM E 1155.

3.03 CURING AND PROTECTION

A. Cure and protect topping applications and finishes as specified by the topping manufacturer.

3.04 PERFORMANCES

A. Failure of concrete topping to bond to substrate (as evidenced by a hollow sound when tapped), or disintegration or other failure of topping to perform as a floor finish, will be considered failure of materials and workmanship. Repair or replace toppings in areas of such failures, as directed.

END OF SECTION 03 54 16 00

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SECTION 04 20 00 00 - UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.03 QUALITY ASSURANCE

A. Single Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

B. Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

C. Field Constructed Mock Ups: Prior to installation of unit masonry, erect sample wall panels to further verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock ups to comply with the following requirements, using materials indicated for final unit of Work:

1. Locate mock ups on Site in locations indicated or, if not indicated, as approved by Architect.
2. Build mock ups for the following types of masonry in sizes of approximately 4 feet long by 4 feet high by full thickness, including face and backup wythes as well as accessories.
    a. Each type of exposed unit masonry construction.
    b. Typical exterior face brick wall.
    c. Typical exterior face brick wall with framed window opening.
    d. Typical interior unit masonry wall.
3. Where masonry is to match existing, erect panels parallel to existing surface.
4. Notify Architect one week in advance of the dates and times when mock ups will be erected.

5. Protect mock ups from the elements with weather resistant membrane.

6. Retain and maintain mock ups during construction in undisturbed condition as standard for judging completed unit masonry construction.

   a. When directed, demolish and remove mock ups from the Project Site.

   b. Accepted mock ups in undisturbed condition at time of Substantial Completion may become part of completed unit of Work.

D. Preinstallation Conference: Conduct conference at the Project Site to comply with requirements of Division 01.

1.04 SUBMITTALS

A. Product Data:

1. Material certificates for the following signed by manufacturer and Contractor certifying that each material complies with requirements.

   a. Each different cement product required for mortar and grout including name of manufacturer, brand, type, and weight slips at time of delivery.

   b. Each material and grade indicated for reinforcing bars.

   c. Each type and size of joint reinforcement.

      1) Each type and size of anchors, ties, and metal accessories.

B. Samples:

1. Samples for initial selection purposes of the following:

   a. Unit masonry samples in small scale form showing full extent of colors and textures available for each different exposed masonry unit required.

   b. Colored masonry mortar samples showing full extent of colors available.

2. Samples for verification purposes of the following:

   a. Full size units for each different exposed masonry unit required showing full range of exposed color, texture, and dimensions to be expected in completed construction.

      1) Include size variation data verifying that actual range of sizes for brick falls within ASTM C 216 dimension tolerances for brick where modular dimensioning is indicated.

   b. Colored masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.

   c. Weep holes/vents in color to match mortar color.

   d. Accessories embedded in the masonry.

C. Record Documents:

1. Shop drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315 "Details and Detailing of Concrete Reinforcing" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement.

2. Cold weather construction procedures evidencing compliance with requirements specified in referenced unit masonry standard.

3. Hot weather construction procedures evidencing compliance with requirements specified in referenced unit masonry standard.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver masonry materials to Project in undamaged condition.

B. Store and handle masonry units off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air dried condition.

C. Store cementitious materials off the ground, under cover, and in dry location.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

E. Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

1.06 PROJECT CONDITIONS

A. During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

   1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

   2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar, and soil that comes in contact with such masonry.

   1. Protect base of walls from rain splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

   2. Protect sills, ledges, and projections from mortar droppings.

   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes from mortar droppings.

D. Cold Weather Construction: Comply with referenced unit masonry standard for cold weather construction and the following:

   1. Do not lay masonry units that are wet or frozen.

2. Remove masonry damaged by freezing conditions.

E. Hot Weather Construction: Comply with referenced unit masonry standard.

1.07 ALLOWANCES

A. Furnish face brick, excluding special molded shapes.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Comply with referenced unit masonry standard and other requirements specified in this Section applicable to each material indicated.

2.02 BRICK UNITS

A. Comply with the following requirements applicable to each form of brick required:

1. Provide special molded shapes where indicated and as follows:

   a. For applications requiring brick of form, color, texture, and size on exposed surfaces that cannot be produced by sawing standard brick sizes.

   b. For applications where stretcher units cannot accommodate special conditions including those at corners, movement joints, bond beams, sashes, and lintels.

2. Provide units without cores or frogs and with all exposed surfaces finished for ends of sills, caps, and similar applications that expose brick surfaces that otherwise would be concealed from view.

B. Face Brick Standard: ASTM C 216 and as follows:

1. Grade and Unit Compressive Strength: Provide units of grade SW and minimum average net area compressive strength not less than the unit compressive strengths required to produce clay masonry construction of compressive strength indicated.

2. Type FBS (for general use in exposed masonry requiring wider variations in size and color ranges than Type FBX).

3. Type FBX (for general use in exposed masonry requiring minimum variations in size and color ranges).

4. Type FBA (for special architectural effects resulting from non-uniformity in size, color, and texture of individual units).

5. Provide bricks manufactured to the dimensions within the tolerances specified in ASTM C 216 for Standard Modular Brick; 3-5/8 inches thick by 2-1/4 inches high by 7-5/8 inches long.

6. Application: Use where brick is exposed, unless otherwise indicated.

7. Wherever shown to "match existing," provide face brick of matching color, texture, and size as existing adjacent brickwork.

8. Color and Texture: Match Architect's sample.

2.03 CONCRETE MASONRY UNITS

A. Comply with requirements indicated below applicable to each form of concrete masonry unit required.

  1. Provide special shapes where indicated and as follows:

    a. For lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.

    b. Bullnose units for outside corners unless otherwise indicated.

    c. Square edged units for outside corners, except where indicated as bullnose.

  2. Size: Provide concrete masonry units complying with requirements indicated below for size that are manufactured to specified face dimensions within tolerances specified in the applicable referenced ASTM specification for concrete masonry units.

    a. Concrete Masonry Units: Manufactured to specified dimensions of 3/8 inch less than nominal widths by nominal heights by nominal lengths indicated on drawings.

    b. Prefaced Concrete Masonry Units: Manufactured to specified dimensions of 3/8 inch less than nominal widths by nominal heights by nominal lengths indicated on drawings, with prefaced surfaces having 1/16 inch thick returns of facing to create 1/4 inch wide mortar joints with modular coursing.

  3. Provide Type I, moisture controlled units.

  4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

    a. Where special finishes are indicated, provide units with exposed faces of the following general description matching color and texture of Architect's sample.

      1) Standard aggregate, ground finish

      2) Special aggregate, ground finish

      3) Standard aggregate, split face finish

      4) Special aggregate, split face finish

      5) Standard aggregate, split ribbed finish

      6) Special aggregate, split ribbed finish

    b. Where special patterns are indicated, provide units with exposed faces matching color, texture and pattern of Architect's sample.

B. Hollow Load Bearing Concrete Masonry Units: ASTM C 90, and as follows:

  1. Unit Compressive Strength: Provide units with minimum average net area compressive strength not less than the unit compressive strengths required to produce concrete unit masonry construction of compressive strength indicated.

  2. Weight Classification: Lightweight unless otherwise indicated or required by Project conditions.

C. Solid Load Bearing Concrete Masonry Units: ASTM C 90, and as follows:

1. Unit Compressive Strength: Provide units with minimum average net area compressive strength not less than the unit compressive strengths required to produce concrete unit masonry construction of compressive strength indicated.

2. Weight Classification: Lightweight unless otherwise indicated or required by Project conditions.

D. Prefaced Concrete Block: Lightweight concrete units indicated below with manufacturer's standard smooth resinous tile facing complying with ASTM C 744:

1. For units on which prefaced surfaces are molded, comply with the following:

   a. Hollow Load Bearing Concrete Block: ASTM C 90

   b. Unit Compressive Strength: Provide units with minimum average net area compressive strength not less than the unit compressive strengths required to produce concrete unit masonry construction of compressive strength indicated.

2. Color and Pattern: Match Architect's sample

3. Color and Pattern: Provide color and pattern selected by Architect from manufacturer's full range of standard colors and patterns.

4. Available Products: Subject to compliance with requirements, prefaced concrete masonry units that may be incorporated in the Work include, but are not limited to, the following:

   a. "Astra Glaze," Trenwyth Industries, Inc.

   b. "Spectra Glaze II," The Burns & Russell Co.

2.04 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold weather construction. Provide natural color or white cement as required to produce required mortar color.

B. Mortar Cement: U.B.C. Standard No. 21-14

1. For pigmented mortars, use premixed, colored martar cements of formulation required to produce color indicated, or if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 5 percent of mortar cement by weight for mineral oxides nor 1 percent for carbon black.

C. Ready Mixed Mortar: Cementitious materials, water, and aggregate complying with requirements specified in this article, combined with set controlling admixtures to produce a ready mixed mortar complying with ASTM C 1142.

D. Hydrated Lime: ASTM C 207, Type S

E. Aggregate for Mortar: ASTM C 144, except for joints less than 1/4 inch use aggregate graded with 100 percent passing the No. 16 sieve.

1. White Mortar Aggregates: Natural white sand or ground white stone

2. Colored Mortar Aggregates: Ground marble, granite, or other sound stone, as required to match Architect's sample.

F. Aggregate for Grout: ASTM C 404

G. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars.

H. Water: Clean and potable

2.05 REINFORCING STEEL

A. Provide reinforcing steel complying with requirements of referenced unit masonry standard and this article.

B. Steel Reinforcing Bars: Material and grade as follows:

1. Billet steel complying with ASTM A 615

2. Epoxy coated billet steel complying with ASTM A 615 and ASTM A 775

3. Grade 60

C. Deformed Reinforcing Wire: ASTM A 496

D. Plain Welded Wire Fabric: ASTM A 185

E. Deformed Welded Wire Fabric: ASTM A 497

2.06 JOINT REINFORCEMENT

A. Provide joint reinforcement complying with requirements of referenced unit masonry standard and this article, formed from galvanized carbon steel wire, coating class as required by referenced unit masonry standard for application indicated.

B. Description: Welded wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with prefabricated corner and tee units, and complying with requirements indicated below:

1. Wire Diameter for Side Rods: 0.1483 inch (9 gage)

2. Wire Diameter for Cross Rods: 0.1483 inch (9 gage)

3. For single wythe masonry provide type as follows with single pair of side rods:

   a. Ladder design with perpendicular cross rods spaced not more than 16 inches on center.

   b. Truss design with continuous diagonal cross rods spaced not more than 16 inches on center.

4. For multiwythe masonry provide type as follows:

   a. Tab design with single pair of side rods and rectangular box type cross ties spaced not more than 16 inches on center; with side rods spaced for embedment within each face shell of backup wythe and ties extended to engage the outer wythe by at least 1½ inches.

b. Acceptable products include Masonry Reinforcing Corp. "Series 800", Dur O waL "Ladur-Eye", or Hohman & Barnard "Hookit with 2Z Ties".

2.07 TIES AND ANCHORS, GENERAL

A. Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of referenced unit masonry standard and of this article.

B. Galvanized Carbon Steel Wire: ASTM A 82, coating class as required by referenced unit masonry standard for application indicated.

C. Galvanized Steel Sheet: ASTM A 366 (commercial quality) cold rolled carbon steel sheet, hot dip galvanized after fabrication to comply with ASTM A 525, Class B2 (for unit lengths over 15 inches) and Class B3 (for unit lengths under 15 inches), for sheet metal ties and anchors.

2.08 ADJUSTABLE ANCHORS FOR CONNECTING MASONRY TO STRUCTURAL FRAMEWORK

A. Two piece assemblies as described below allowing vertical or horizontal differential movement between wall and framework parallel to plane of wall, but resisting tension and compression forces perpendicular to it.

B. For anchorage to concrete framework, provide manufacturer's standard with dovetail anchor section formed from sheet metal and triangular shaped wire tie section sized to extend within 1 inch of masonry face and as follows:

1. Furnish dovetail slots to concrete trade for installation.
2. Acceptable products include Masonry Reinforcing Corp. "1304/2102", Dur O waL "D/A100/D/A720 723", or Heckman "100/103".

C. For anchorage to steel framework provide manufacturer's standard anchors with crimped 1/4 inch diameter wire anchor section for welding to steel and triangular shaped wire tie section sized to extend within 1 inch of masonry face and as follows:

1. Acceptable products include Masonry Reinforcing Corp. "1000, Type 1/1100", Dur O waL "D/A100/D/A720 723", or Heckman "100/103".

2.09 RIGID ANCHORS

A. Provide straps of form and length indicated, fabricated from metal strips of following width and thickness.

1. 1½ inches wide by ¼ inch thick.
2. As indicated.

2.10 ADJUSTABLE MASONRY VENEER ANCHORS

A. Provide two piece assemblies allowing vertical or horizontal differential movement between wall and framework parallel to plane of wall, but resisting tension and compression forces perpendicular to it; for attachment over sheathing to metal studs; and with the following structural performance characteristics:

1. Structural Performance Characteristics: Capable of withstanding a 100 pound/foot load in either tension or compression without deforming over, or developing play in excess of, 0.05 inch.

B. Provide anchors and ties as specified below with all components hot-dipped galvanized after fabrication. Size ties to extend to within ¾ inch of outside face of brick veneer.

1. Brick Veneer Anchors at Metal Stud Back Up Construction: Flexible two piece anchors consisting of 3/16 inch diameter trapezoidal shaped wire ties and 16 gage minimum steel strap designed for screw attachment into metal stud framing.

   a. Acceptable products include Hohman & Barnard "DW 10/VWT", Masonry Reinforcing Corp. "1004/1100", or Dur O WaL "D/A213-.5/D/A701 708".

2. Brick Veneer Anchors at Solid Back Up Construction: Flexible two piece anchors consisting of 3/16 inch diameter trapezoidal shaped wire ties with 16 gage channel locking tab and 16 gage minimum steel "channel slot" designed for surface attachment to concrete or CMU back up.

   a. Acceptable products include Masonry Reinforcing Corp. "1302/2103", Dur O WaL "D/A901/918 921", or Heckman "132/129".

C. Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, #10 diameter by length required to penetrate steel stud flange by not less than 3 exposed threads, and with the following corrosion protective coating:

1. Organic polymer coating with salt spray resistance to red rust of more than 800 hours per ASTM B 117.

2. Organic Polymer Coated Steel Drill Screws:

   a. "Traxx," ITW Buildex

   b. "Dril Flex," Elco Industries, Inc.

2.11 MISCELLANEOUS ANCHORS

A. Unit Type Masonry Inserts in Concrete: Cast iron or malleable iron inserts of type and size indicated.

B. Dovetail Slots: Furnish dovetail slots, with filler strips, of slot size indicated, fabricated from 0.0336 inch (22 gage) sheet metal.

C. Anchor Bolts: Steel bolts complying with A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations:

1. Headed bolts.

2. Nonheaded bolts, straight.

3. Nonheaded bolts, bent in manner indicated.

2.12 POSTINSTALLED ANCHORS

A. Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing laboratory.

1. Type: Chemical anchors.

2. Type: Expansion anchors.

3. Type: Undercut anchors.

4. Corrosion Protection: Carbon steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).

5. Corrosion Protection: Stainless steel components complying with ASTM F 593 and ASTM F 594, Group 1 alloy 304 or 316 for bolts and nuts; alloy 304 or 316 for anchor.

6. For cast in place and post-installed anchors in concrete: Capability to sustain, without failure, a load equal to 4 times loads imposed by masonry.

7. For post-installed anchors in grouted concrete masonry units: Capability to sustain, without failure, a load equal to 6 times loads imposed by masonry.

2.13 EMBEDDED THROUGH-WALL FLASHING MATERIALS

A. Copper Fabric Laminate: 5 ounce copper sheet bonded with asphalt between 2 layers of glass fiber cloth.

   1. "Copper Fabric," Afco Products Inc.

   2. "Type FCC Fabric Covered Copper," Phoenix Building Products

   3. "Copper Fabric Flashing," Sandell Manufacturing Co., Inc.

   4. "York Copper Fabric Flashing," York Manufacturing, Inc.

B. Adhesive for Flashings: Of type recommended by manufacturer of flashing material for use indicated.

2.14 MISCELLANEOUS MASONRY ACCESSORIES

A. Expansion and Control Joint Fillers:

   1. Pre-molded Expansion Joint Filler: Closed cell polyethylene foam material with a density of ±2 psf, and compatible with most sealants. Acceptable products include Sonneborn "Sonoflex F" and Williams Products Inc. "Expand O Foam 1380 Series".

   2. Construction Joint Filler: Closed cell expanded neoprene foam material with a density of 15 to 35 psf, flame resistant, and compatible with most sealants. Acceptable products include Williams Products Inc. "Neoprene Type NN1" and Rubatex Corp. "R 1800 FS".

   3. Pre-molded Control Joint Strip: Solid rubber strips with a Shore A durometer hardness of 60 to 80, designed to fit standard sash blocks and maintain lateral stability of masonry wall. Provide strips in width approximately 2" less than thickness of masonry wythe. Acceptable products include Dur O waL "Rapid Control Joint" and Hohman & Barnard "QS Series".

B. Bond Breaker Strips: Asphalt saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

C. Weep Holes: Provide one of the following at Contractor's option:

   1. Aluminum Weep Hole/Vent: One piece L shaped units made to fit in a vertical mortar joint from sheet aluminum and consisting of a vertical channel with louvers stamped in web and a flat horizontal; pre-painted prior to installation, in color to match that of masonry or mortar as selected by Architect.

a. "Louvered Weephole", Masonry Reinforcing Corp.

2. Plastic Weep Hole/Vent: One piece flexible extrusion manufactured from ultraviolet resistant polypropylene co polymer, designed to weep moisture in masonry cavity to exterior, sized to fill head joints with outside face held back 1/8 inch from exterior face of masonry, in custom color to match that of masonry or mortar as selected by Architect.

   a. "Cell Vent," Dur O Wal, Inc.

D. Cavity Drainage Material: To prevent mortar from blocking cavity weep holes, provide one of the following:

1. 1-inch-(25-mm-) thick, reticulated, nonabsorbent mesh, made from polyethylene strands and shaped to maintain drainage at weep holes without being clogged by mortar droppings. Product: "Mortar Net".

2.15 INSULATION

A. Loose Granular Perlite Insulation: ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or IV (surface treated for water repellency and to limit dust generation).

B. Loose Granular Vermiculite Insulation: ASTM C 516, Type II (surface treated for water repellency and limited moisture absorption), Grade 3 (Fine), complying with 29 CFR 1926 by containing less than 0.10 percent by weight of asbestos and that demonstration shows will not release asbestos fibers in excess of 0.1 fibers per cubic centimeter under reasonably foreseeable Site conditions.

C. Extruded Polystyrene Board Insulation: Rigid cellular polystyrene thermal insulation with closed cells and integral high density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578, Type IV; in manufacturer's standard lengths and widths; thicknesses as indicated.

D. Molded Polystyrene Board Insulation: Rigid, cellular thermal insulation formed by the expansion of polystyrene resin beads or granules in a closed mold to comply with ASTM C 578, Type I; in manufacturer's standard lengths and widths; thicknesses as indicated.

1. Provide specially shaped units designed for installation in cores of concrete blocks.

E. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.16 MORTAR AND GROUT MIXES

A. Do not add admixtures including coloring pigments, air entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:

C. Proportions listed are in the following order, by volume of cementitious materials: (Portland Cement):(Hydrated Lime or Lime Putty):(Aggregate). Aggregate volume is based on the sum of the separate volumes of other cementitious materials.

1. Limit cementitious materials in mortar to portland cement lime.

2. Use Type M mortar for masonry below grade and in contact with earth, and where indicated: (1):(1/4):(2 1/4 to 3).

3. Use Type S mortar for reinforced masonry: (1):(1/4 to 1/2):(2 1/4 to 3).

4. Use Type N mortar for all other exterior and interior walls: (1):(1/2 to 1 1/4):(2 1/4 to 3).

5. Colored Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment to-cement ratio of 1:10, by weight. Match Architect's sample.

D. Provide grout complying with ASTM C 476, of consistency indicated or, if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout.

1. Provide grout in the following proportions, by volume: (1 part portland cement):(0 to 1/10 part hydrated lime or lime putty):(aggregate, 2½ to 3 times the sum of the volumes of other cementitious materials). Add coarse aggregate in the proportion of 1 to 2 times the sum of the volumes of other cementitious materials for "coarse" grout.

2. Use fine grout in grout spaces less than 2 inches in horizontal direction, unless otherwise indicated.

3. Use coarse grout in grout spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of unit masonry.

B. Examine rough in and built in construction to verify actual locations of piping connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Comply with referenced unit masonry standard and other requirements indicated applicable to each type of installation included in Project.

D. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single wythe walls to the actual thickness of the masonry units, using units of nominal thickness indicated.

E. Build chases and recesses as shown or required to accommodate items specified in this and other Sections of the Specifications. Provide not less than 8 inches of masonry between chase or recess and jamb of openings and between adjacent chases and recesses.

F. Leave openings for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.

G. Cut masonry units with motor driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full size units without cutting where possible.

H. Matching Existing Masonry: Match coursing, bonding, color, and texture of new masonry with existing masonry.

3.03 CONSTRUCTION TOLERANCES

A. Comply with construction tolerances of referenced unit masonry standard.

3.04 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement type joints, returns, and offsets. Avoid the use of less than half size units at corners, jambs, and where possible at other locations.

B. Lay up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less that nominal 4 inch horizontal face dimensions at corners or jambs.

1. One half running bond with vertical joint in each course centered on units in courses above and below.
2. Stack bond
3. One third running bond
4. As indicated on drawings

D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4 inch horizontal face dimensions at corners or jambs.

E. Stopping and Resuming Work: In each course, rack back 1/2 unit length for one half running bond or 1/3 unit length for one third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.

F. Built In Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built in items.

1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

a. At exterior frames insert extruded polystyrene board insulation around perimeter of frame in thickness indicated but not less than ¾ inch to act as a thermal break between frame and masonry.

2. Where built in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

3. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.05 MORTAR BEDDING AND JOINTING

A. Lay brick units with full mortar coverage on bed and head joints. Furrowing of joints will not be permitted.

B. Lay hollow concrete masonry units as follows:

1. With full mortar coverage on horizontal and vertical face shells.

2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.

3. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

C. Cut joints flush for masonry walls to be concealed or to be covered by other materials, unless otherwise indicated.

3.06 STRUCTURAL BONDING OF MULTIWYTHE MASONRY

A. Use individual metal ties installed in horizontal joints to bond wythes together.

B. Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes.

C. Use either of the structural bonding systems specified above.

D. Use structural bonding system indicated on Drawings.

E. Corners: Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.

1. Provide continuity with horizontal joint reinforcement at corners using prefabricated "L" units, in addition to masonry bonding.

F. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:

1. Provide individual metal ties.

2. Provide continuity with horizontal joint reinforcement using prefabricated "T" units.

G. Nonbearing Interior Partitions: Build full height of story to underside of solid floor or roof structure above and as follows:

1. Install pressure relieving joint filler in joint between top of partition and underside of structure above.

3.07 CAVITIES/AIR SPACES

A. Keep cavities/air spaces clean of mortar droppings and other materials during construction. Strike joints facing cavities/air spaces flush.

B. Tie exterior wythe to backup with individual metal ties. Stagger alternate courses.

C. Tie exterior wythe to backup with continuous horizontal joint reinforcing.

D. Install vents in vertical head joints at the top of each continuous cavity/air space. Space vents and close off cavities/air spaces vertically and horizontally with blocking in manner indicated.

3.08 CAVITY WALL AND MASONRY CELL INSULATION

A. On units of plastic insulation, install small pads of adhesive spaced approximately 1' 0" on center both ways on inside face or attach to inside face with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

   1. Fill all cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

B. Pour granular insulation into cavities as shown to fill void spaces completely. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close ports after complete coverage has been confirmed. Limit fall of insulation to one story in height, but not to exceed 20 feet.

3.09 HORIZONTAL JOINT REINFORCEMENT

A. Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcing a minimum of 6 inches.

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as approved by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

   1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.

   2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.

   3. Space anchors as indicated, but not more than 24 inches on center vertically and 36 inches on center horizontally.

3.11 ANCHORING SINGLE WYTHE MASONRY VENEER

A. Anchor single wythe masonry veneer to metal studs with masonry veneer anchors to comply with the following requirements:

1. Fasten each anchor section through sheathing to metal studs with 2 metal fasteners of type indicated.

2. Embed tie section in masonry joints. Provide not less than 2 inch air space between back of masonry veneer wythe and face of sheathing.

3. Locate anchor section relative to course in which tie section is embedded to allow maximum vertical differential movement of tie up and down.

4. Space anchors as indicated but not more than 16 inches on center vertically and 18 inches on center horizontally with not less than one anchor for each 3 square feet of wall area. Install additional anchors within 12 inches of openings and at intervals around perimeter not exceeding 8 inches.

B. Install vents at the top of each continuous air space in masonry veneer walls.

3.12 MOVEMENT (CONTROL AND EXPANSION) JOINTS

A. Install control and expansion joints in unit masonry where indicated. Build in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in plane restraint of wall or partition movement.

B. Joint Spacing: If location of control joints and expansion joints is not shown, place vertical joints spaced not to exceed 35 feet on center and horizontal joints not to exceed story height.

1. Locate control joints in face brick at all points of discontinuity of back up construction, vertical and horizontal.

C. Form control joints in concrete masonry as follows:

1. Fit bond breaker strips into hollow contour in ends of block units on one side of control joint. Fill the resultant core with grout and rake joints in exposed faces.

2. Install preformed control joint gaskets designed to fit standard sash block.

3. Install special shapes designed for control joints. Install bond breaker strips at joint. Keep head joints free and clear of mortar or rake joint.

D. Form expansion joints in brick made from clay or shale as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints, if any.

2. Build flanges of factory fabricated expansion joint units into masonry.

3. Build in joint fillers where indicated.

4. Form open joint of width indicated but not less than 3/8 inch for installation of sealant and backer rod. Maintain joint free and clear of mortar.

E. Build in horizontal pressure relieving joints where indicated; construct joints by either leaving an air space or inserting nonmetallic 50 percent compressible joint filler of width required to permit installation of sealant and backer rod.

   1. Locate horizontal pressure relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.13 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and wherever openings of more than 12 inches for brick size units and 24 inches for block size units are shown without structural steel or other supporting lintels. Provide precast or formed in place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed in place lintels.

   1. For hollow concrete masonry unit walls, use specially formed bond beam units with reinforcement bars placed as indicated and filled with coarse grout.

C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.14 THROUGH-WALL FLASHING/WEEP HOLES

A. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.

B. Prepare masonry surfaces so that they are smooth and free from projections that could puncture flashing. Place through wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive/sealant/tape as recommended by flashing manufacturer before covering with mortar.

C. Install flashings as follows:

   1. At masonry backup construction, extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 8 inches, and through the inner wythe to within ½ inch of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches, unless otherwise indicated.

   2. At sheathing backup construction, extend flashing from exterior face of outer wythe of masonry, through the outer wythe to the face of the sheathing, and turn up a minimum of 8 inches onto the sheathing.

      a. Fully adhere flashing to substrate with adhesive; using a roller or other device to ensure full and complete adhesion.

      b. At joints, lap flashing sheets a minimum of 4 inches onto adjacent sheet and seal with adhesive.

   3. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end.

   4. At heads and sills, extend flashing as specified above unless otherwise indicated but turn up ends not less than 2 inches to form a pan.

   5. Turn down sheet metal flashings at exterior face of masonry to form drip.

6. Strip in top edge of flashing installed against inner face of cavity with mastic and reinforcing fabric.

D. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashings and as follows:

1. Form weep holes by using open head-joints in brick veneer.

2. Form weep holes with product specified in Part 2 of this Section.

3. Space weep holes 24 inches on center.

4. In uninsulated cavities/air spaces place cavity drainage material immediately above flashing embedded in the wall, as masonry construction progresses, to splatter mortar droppings and to maintain drainage.

E. Install reglets and nailers for flashing and other related construction where shown to be built into masonry.

3.15 INSTALLATION OF REINFORCED UNIT MASONRY

A. Install reinforced unit masonry to comply with requirements of referenced unit masonry standard.

1. Provide continuous vertical reinforcing as indicated on the Drawings or otherwise required, including additional reinforcing bars at corners, around openings, at attachments of other work, and similar work.

2. Install bars to provide proper embedment and laps where indicated as "continuous reinforcing".

3. Fill cores containing vertical reinforcing with grout to full height of wall.

B. Temporary Formwork: Construct formwork and shores to support reinforced masonry elements during construction.

1. Construct formwork to conform to shape, line, and dimensions shown. Make sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

C. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.

D. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

3.16 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance, prepared for application of sealants.

C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave ½ panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.

4. Wet wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.

5. Clean brick by means of bucket and brush hand cleaning method described in BIA "Technical Note No. 20 Revised".

6. Clean concrete masonry by means of cleaning method indicated in NCMA TEK 45 applicable to type of stain present on exposed surfaces.

D. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

END OF SECTION 04 20 00 00

SECTION 04 23 13 00 - GLASS UNIT MASONRY VERTICAL ASSEMBLIES

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for glass unit masonry assemblies. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes
      a. Glass block set in mortar.
      b. Glass block set in silicone sealant.
      c. Glass block set in glass-block grid systems.

C. Performance Requirements
   1. Structural Performance: Provide glass-block grid systems capable of withstanding the effects of gravity loads and the loads and stresses within limits and under conditions indicated.

D. Action Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittals:
      a. Product Data for Credit IEQ 4.1: For sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
      b. Laboratory Test Reports for Credit IEQ 4: For sealants used inside the weatherproofing system, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   3. Shop Drawings: Show fabrication and installation details for glass unit masonry, including vertical and horizontal coursing, anchors, reinforcement, and expansion strips and glass-block grid systems.
   4. Provide Samples for each form, pattern, and color of glass block and color of joint material and glass-block grid material indicated or selected by UT Health.
   5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, documentation including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Informational Submittals
   1. Qualification Data: For qualified professional engineer.

F. Quality Assurance
   1. Fire-Rated Glass Unit Masonry Assemblies: Assemblies listed by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 **OR** UBC Standard 7-4, **as directed**.
      a. Test Pressure: Test at atmospheric pressure **OR** After 10 minutes into the test, neutral pressure level in furnace shall be located so that at least two-thirds of test specimen is above the neutral pressure plane, **as directed**.

G. Delivery, Storage, And Handling
   1. Store glass block in unopened cartons on elevated platforms, under cover, and in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

2. Store glass-block grid materials in unopened cartons in an enclosed, dry location.
3. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
4. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
5. Store accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

H. Project Conditions
1. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below 40 deg F (5 deg C) or when joint substrates are wet.
2. Weather Limitations: Proceed with installation of glass unit masonry assemblies only when ambient and material temperatures are 40 deg F (5 deg C) or higher.
   a. Maintain temperature in installation areas at 40 deg F (5 deg C) or above for 48 hours after installing.

I. Sequencing And Scheduling
1. Sequence and coordinate completion of glass unit masonry assemblies so sealants can be installed immediately after mortar has attained final set.

1.2 PRODUCTS

A. Glass Block
1. Hollow Glass Block: Hollow units made from transparent glass, with manufacturer's standard edge coating.
   a. Glass Color: As selected from manufacturer's full range.
   b. Pattern:
      1) Smooth, undistorted inner and outer faces.
      2) Wavy, light-diffusive design on inner faces, and smooth outer faces.
      3) Fluted, light-diffusive design, horizontal on one inner face, vertical on other; and smooth outer faces.
      4) Linear prismatic design, horizontal on one inner face, vertical on other; and smooth outer faces.
      5) Prismatic pyramid, light-diffusive design on inner faces, and smooth outer faces.
      6) As indicated by manufacturer's designation.
      7) Manufacturer's standard decorative pattern to match sample.
      8) As selected from manufacturer's full range.
      9) Custom decorative pattern to match design.
   c. Edge-Coating Color: As selected from manufacturer's full range.
   d. Sizes: Manufacturer's standard sizes corresponding to nominal sizes indicated on Drawings.
   e. Thick-Faced Units: Units with faces at least 3/4 inch (19 mm) thick.
2. Solid Glass Block: Colorless, transparent, solid glass blocks with smooth **OR** stippled, **as directed**, faces and manufacturer's standard edge coating.
   a. Square-Block Size: 5-3/4 inches (146 mm) **OR** 7-3/4 inches (197 mm) **OR** 11-3/4 inches (299 mm) **as directed**, square by 1-1/2 inches (38 mm) **OR** 3 inches (76 mm) thick, actual size, **as directed**.
   b. Rectangular-Block Size: 3 by 7-3/4 inches (76 by 197 mm) **OR** 5-3/4 by 7-3/4 inches (146 by 197 mm), **as approved by** 1-1/2 inches (38 mm) **OR** 3 inches (76 mm) thick, actual size, **as directed**.
3. Glass Paver Block: Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; **6 inches (152 mm) square by 1 inch (25 mm) OR 4-3/4 inches (120 mm) square by 1-9/16 inches (40 mm) OR 6-5/16 inches (160 mm) square by 1-3/16 inches (30 mm) OR 7-1/2 inches (190 mm) square by 1-1-15/16 inches (50 mm) OR 7-1/2 inches (190 mm) square by 2-3/4 inches (70 mm) OR 7-7/8 inches**

(200 mm) square by 7/8 inch (22 mm) OR 7-7/8 inches (200 mm) square by 1-15/16 inches (50 mm) OR 4-5/8 inches (117 mm) in diameter by 2-3/8 inches (60 mm) thick, actual size, **as directed.**
  - a.

B. Glass-Block Grid Systems

1. General: Aluminum extrusions complying with ASTM B 221 (ASTM B 221M), Alloy 6063-T6 or Alloy 6463-T6, forming a grid system and frame designed for application indicated.
2. Window and Wall System: Aluminum T-bar grid with tubular frame and vinyl glass-block boots.
   - a. Finish: As selected from manufacturer's full range.
   - b. Glass-Block Size: 7-3/4 inches (197 mm) square by 3-1/8 inches (79 mm) thick.
   - c. Provide self-flashing, **as directed**, aluminum exterior frame covers with vinyl thermal break.
   - d. Provide extruded-aluminum frame receivers (corner starters) at heads, jambs, and sills.
   - e. Provide extruded-aluminum mullions where indicated.
   - f. Provide aluminum trim and closures as indicated.
3. Skylight System: Aluminum T-bar grid with tubular frame; vinyl thermal break; extruded-aluminum, curb-mounting frame and counterflashing; and vinyl glass-block boots.
   - a. Finish: As selected from manufacturer's full range.
   - b. Glass-Block Size: 7-3/4 inches (197 mm) square by 3-1/8 inches (79 mm) thick.
4. Floor System: Aluminum tubular grid and frame with glass-block boots made from UV- and oil-resistant EPDM.
   - a. Finish: Class II, clear-anodized finish; complying with AAMA 611.
   - b. Glass-Paver-Block Size: 6 inches (152 mm) square by 1 inch (25 mm) thick.
5. Sealant: Product recommended by glass-block grid system manufacturer.
   - a. Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mortar Materials

1. Portland Cement: ASTM C 150, Type I or Type II, natural color or white cement as required to produce mortar color indicated.
   - a. Where joints are indicated to be raked out and pointed, gray cement may be used for setting mortar.
2. Hydrated Lime: ASTM C 207, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
4. Masonry Cement: ASTM C 91.
5. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
6. Colored Cement Product: Packaged blend made from portland cement and lime **OR** masonry cement, **as directed**, and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   - a. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   - b. Pigments shall not exceed 10 percent of portland cement **OR** 5 percent of masonry cement, **as directed**, by weight.
7. Aggregate: ASTM C 144, with 100 percent passing No. 8 (2.36-mm) sieve.
   - a. For pointing mortar and joints narrower than 1/4 inch (6 mm), use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   - b. White Aggregates: Natural white sand or crushed white stone.
   - c. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
8. Water-Repellent Admixture: Manufacturer's standard dry mixture of stearates, water-reducing agents, and fine aggregates intended to reduce capillarity in mortar.
9. Water-Repellent Admixture: Liquid polymeric water-repellent mortar admixture that does not reduce flexural bond strength of mortar.

10. Water: Potable.

D. Glass Unit Masonry Accessories

1. Panel Reinforcement: Ladder-type units, butt welded, not lapped and welded; complying with ASTM A 951 in straight lengths of not less than 10 feet (3 m), and as follows:
    a. Interior Walls: Hot-dip galvanized, carbon-steel wire.
    b. Exterior Walls: Hot-dip galvanized, carbon-steel **OR** Stainless-steel, **as directed**, wire.
    c. Wire Size: W1.7 or 0.148-inch (3.8-mm) diameter.
    d. Width: 2 inches (50 mm) **OR** 1-5/8 inches (40 mm), **as directed**.
    e. Spacing of Cross Rods: Not more than 16 inches (407 mm) apart.
2. Panel Anchors: Glass-block manufacturer's standard perforated steel strips, 0.0359 inch (0.9 mm) by 1-3/4 inches (44 mm) wide by 24 inches (600 mm) long, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
3. Mortarless Installation System: System of aluminum or plastic perimeter framing, anchors, and spacers designed for installing glass block with sealant-filled joints.
4. Fasteners, General: Unless otherwise indicated, provide Type 304 or Type 316 stainless-steel fasteners at exterior walls and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at interior walls. Select fasteners for type, grade, and class required.
5. Carbon-Steel Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6) with hex nuts, ASTM A 563 (ASTM A 563M), if applicable.
6. Stainless-Steel Bolts: ASTM F 593 (ASTM F 738M), Alloy Group 1 or 2 (A1 or A4) with hex nuts, ASTM F 594 (ASTM F 836M), if applicable.
7. Postinstalled Anchors: Provide powder-actuated fasteners **OR** metal expansion sleeve anchors **OR** metal impact expansion anchors, **as directed**, of type and size necessary for installation indicated, as recommended by manufacturer, unless otherwise indicated.
8. Asphalt Emulsion: Cold-applied asphalt emulsion complying with ASTM D 1187 or ASTM D 1227.
9. Mineral-Fiber Expansion Strips: Mineral-fiber strips, complying with requirements of fire-rated assembly listing and glass-block manufacturer.
    a. Use for fire-rated assemblies.
10. Plastic-Foam Expansion Strips: Polyethylene foam complying with requirements of glass-block manufacturer; 3/8 inch (9 mm) thick by 4 inches (100 mm) **OR** 3-1/2 inches (89 mm) **OR** 2-1/2 inches (63 mm) wide, **as directed.**
    a. Use plastic-foam expansion strips for non-fire-rated assemblies **OR** fire-rated and non-fire-rated assemblies, **as directed**.
11. Sealants: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants".
    a. Single-component, neutral-curing **OR** acid-curing, **as directed**, silicone sealant.
    b. Single-component, nonsag urethane sealant.
    c. Multicomponent, nonsag polysulfide sealant.
    d. Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    e. Sealant Accessories: Provide sealant accessories, including primers, bond-breaker tape, and cylindrical sealant backing, that comply with applicable requirements in Division 07 Section "Joint Sealants".

E. Mortar Mixes

1. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, or antifreeze compounds, unless otherwise indicated.
    a. Do not use calcium chloride in mortar.
    b. For mortar in exterior panels, use water-repellent admixture according to admixture manufacturer's written instructions.
    c. For pointing mortar in exterior panels, use water-repellent admixture according to admixture manufacturer's written instructions.
    d. Limit cementitious materials in mortar to portland cement and lime.

2. Mortar for Glass Unit Masonry Assemblies: Provide mortar, mixed according to glass-block manufacturer's listing with testing and inspecting agency, for fire-resistance rating indicated.
   OR
   Mortar for Glass Unit Masonry Assemblies: Comply with ASTM C 270, Proportion Specification for Type S mortar.
   a. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Mix mortar to produce a stiff but workable consistency that is drier than mortar for brick or concrete masonry. Discard mortar when it has reached initial set.
3. Pigmented Mortar: Use colored cement product **OR** Select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products, **as directed**.
   a. Pigments shall not exceed 10 percent of portland cement by weight.
   b. Pigments shall not exceed 5 percent of masonry cement by weight.
   c. Mix to match sample.
4. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   a. Mix to match sample.

1.3 EXECUTION

A. Examination

1. Examine sills, jambs, and heads surrounding glass unit masonry assemblies for compliance with requirements for installation tolerances and other conditions affecting performance.
   a. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installing Glass Block With Mortar

1. Apply a heavy coat of asphalt emulsion to sill and adhere expansion strips to jambs and heads with asphalt emulsion. Allow asphalt emulsion to dry before placing mortar. Trim expansion strips to width required to fit glass block and to full lengths of heads and jambs.
2. Set glass block with completely filled bed and head joints, with no furrowing, accurately spaced and coordinated with other construction. Maintain 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, exposed joint widths, unless otherwise indicated.
3. Install panel reinforcement in horizontal joints at spacing indicated and continuously from end to end of panels; comply with the following requirements:
   a. Vertical Spacing of Panel Reinforcement for Exterior Panels: Every other course but not more than 16 inches (407 mm) o.c., starting with first course above sill **OR** As indicated on Drawings, **as directed**.
   b. Vertical Spacing of Panel Reinforcement for Interior Panels: Not more than 16 inches (407 mm) o.c. **OR** As indicated on Drawings, **as directed**.
   c. Do not bridge expansion joints with panel reinforcement.
   d. Place panel reinforcement in joints immediately above and below all openings within glass unit masonry assemblies.
   e. Lap panel reinforcement not less than 6 inches (150 mm) if more than 1 length is necessary.
   f. Embed panel reinforcement in mortar bed by placing lower half of mortar bed first, pressing panel reinforcement into place and covering with upper half of mortar bed.
4. Install panel anchors at locations indicated and in same horizontal joints where panel reinforcement occurs. Extend panel anchors at least 12 inches (300 mm) into joints, and bend within expansion joints at edges of panels and across the head. Attach panel anchors as follows:
   a. For in-place unit masonry assemblies and concrete, attach panel anchors with 1/4-inch- (6-mm-) diameter bolt-size, postinstalled anchors, 2 per panel anchor.
   b. For new unit masonry assemblies, embed other ends of panel anchors, after bending portions crossing expansion joint, in horizontal mortar joints closest in elevation to joints in glass unit masonry assemblies containing panel anchors.

        c. For steel members, attach panel anchors with 1/4-inch- (6-mm-) diameter through bolts and nuts or bolts in tapped holes in steel members.
    5. Use rubber mallet to tap units into position. Do not use steel tools, and do not allow units to come into contact with metal accessories and frames.
    6. Use plastic spacers **OR** temporary wedges, **as directed**, in mortar joints to produce uniform joint widths and to prevent mortar from being squeezed out of joints.
        a. If temporary wedges are used, remove them after mortar has set and fill voids with mortar.
    7. Keep expansion joints free of mortar.
    8. Rake out joints indicated to be pointed to a uniform depth sufficient to accommodate pointing material, but not less than joint width.
        a. If temporary wedges are used, remove them before raking out and pointing joints.
        b. Point joints at exterior face **OR** both faces, **as directed**, of exterior panels with mortar.
        c. Point joints at exterior face **OR** both faces, **as directed**, of exterior panels with sealant.
        d. Point joints at both faces of exterior and interior panels with sealant.
    9. Point joints with mortar by filling raked joints and voids. Place and compact pointing mortar in layers not more than 3/8 inch (10 mm) thick. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.
        a. Tool exposed joints slightly concave when pointing mortar is thumbprint hard. Use a smooth plastic jointer larger than joint width.
    10. Point joints by filling with sealant to comply with requirements in Division 07 Section "Joint Sealants".
    11. Clean glass unit masonry assemblies as work progresses. Remove mortar fins and smears immediately, using a clean, wet sponge or a scrub brush with stiff fiber bristles. Do not use harsh cleaners, acids, abrasives, steel wool, or wire brushes when removing mortar or cleaning glass unit masonry assemblies.
    12. Install sealant at jambs, heads, mullions and other locations indicated. Prepare joints, including installation of primer and bond-breaker tape or cylindrical sealant backing, and apply elastomeric sealants to comply with requirements in Division 07 Section "Joint Sealants".
    13. Construction Tolerances: Set glass block to comply with the following tolerances:
        a. Variation from Plumb: For lines and surfaces of vertical elements and arris, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch in 40 feet (12 mm in 12 m) or more.
        b. Variation from Level: For bed joints, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m) , 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more.
        c. Variation of Location in Plan: For location of elements in plan do not vary from that indicated by more than plus or minus 1/4 inch (6 mm).
        d. Variation in Mortar-Joint Thickness: Do not vary from joint thickness indicated by more than plus or minus 1/16 inch (1.5 mm).
        e. For faces of adjacent exposed units, do not vary from flush alignment by more than 1/16 inch (1.5 mm).

C. Installing Glass Block With Sealant
    1. General: Install mortarless glass-block systems according to manufacturer's written instructions.
        a. Fasten frames and anchors or clips securely to surrounding construction.
        b. Shim starting track as needed to make it level.
        c. Adhere glass block to starting track and spacers with silicone sealant.
    2. After glass blocks are installed, apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.

D. Glass-Block Grid System Installation
    1. General: Install glass-block grid systems according to manufacturer's written instructions.
    2. Window and Wall System Installation: Assemble grid system, apply continuous sealant bead to back of window Z-bar, place in position, adjust as needed to make grid level and plumb, and fasten to substrate.

        a. Insert glass blocks into vinyl glass-block boots and carefully insert into grid from exterior side. Install blocks firmly against T-bars without deforming boots.
        b. Apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.
    3. Skylight System Installation: Assemble grid system, apply continuous sealant bead to top of supporting curb, place in position, adjust as needed to bring grid true to line, and fasten to substrate.
        a. Insert glass blocks into vinyl glass-block boots and carefully insert into grid from exterior side. Install blocks firmly against T-bars without deforming boots.
        b. Apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.
    4. Floor System Installation: Assemble grid system in position, adjusting supports as needed to level grid as system is assembled, and fasten to substrate.
        a. Insert glass blocks into glass-block boots and install in grid. Install blocks flush with adjoining floor surfaces and aluminum grid.
        b. Apply sealant to completely fill channel around each glass block and joints of aluminum grid. Tool sealant flush with exterior surface and remove excess sealant and smears.

E. Cleaning
    1. On surfaces adjacent to glass unit masonry assemblies, remove mortar, sealants, and other residue resulting from glass-block installation, in a manner approved by manufacturers of materials involved.
    2. Remove excess sealants with commercial solvents of type recommended by sealant manufacturer. Exercise care not to damage sealant in joints.
    3. Perform final cleaning of glass unit masonry assemblies when surface is not exposed to direct sunlight. Start at top of panel using generous amounts of clean water. Remove water with clean, dry, soft cloths; change cloths frequently to eliminate dried mortar particles and aggregate.

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SECTION 05 12 00 00 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Comply with applicable provisions of the following specifications and documents.

1. AISC's "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design."
2. AISC's "Load and Resistance Factor Design (LFRD) Specification for Structural Steel Buildings."
3. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
4. AISC's "Specification for Load and Resistance Factor Design of Single-Angle Members."
5. AISC's "Seismic Provisions for Structural Steel Building."
6. ASTM A 6 (ASTM A 6M) "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
7. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
8. Research Council on Structural Connections' (RCSC) "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

B. Qualifications for Welding Work: Qualify welding procedures and welding operators in accordance with AWS "Qualification" requirements.

1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.
2. If recertification of welders is required, retesting will be Contractor's responsibility.

1.4 SUBMITTALS

A. Product Data:

1. Product data or manufacturer's specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
    a. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
    b. High strength bolts (each type), including nuts and washers.
        1) Include Direct Tension Indicators if used.
    c. Structural steel primer paint.
    d. Shrinkage resistant grout.

B. Record Documents:

1. Shop drawings prepared under supervision of a licensed Structural Engineer, including complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.
    a. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols and show size, length, and type of each weld.
    b. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.
2. Test reports conducted on shop and field bolted and welded connections. Include data on type(s) of tests conducted and test results.
3. Certified copies of each survey conducted by a licensed Land Surveyor, showing elevations and locations of base plates and anchor bolts to receive structural steel and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

1.5 DELIVERY, STORAGE and HANDLING

A. Deliver materials to the Project Site at such intervals to ensure uninterrupted progress of work.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast in place concrete or masonry, in ample time to not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. If bolts and nuts become dry or rusty, clean and re-lubricate before use.

1. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.6 Performance requirements

A. Engineer structural steel connections required by the Contract Documents to be selected or completed by the fabricator to withstand design loadings indicated.

B. Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 materials

A. Metal Surfaces, General: For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and applying surface finishes.

B. Structural Steel Shapes, Plates, and Bars: ASTM A 36 (ASTM A 36M).

C. Cold Formed Steel Tubing: ASTM A 500, Grade B.

D. Hot Formed Steel Tubing: ASTM A 501.

E. Headed Stud Type Shear Connectors: ASTM A 108, Grade 1015 or 1020, cold finished carbon steel with dimensions complying with AISC Specifications.

F. Anchor Rods, Bolts, Nuts, and Washers: As follows:

1. Unheaded Rods: ASTM A 36 (ASTM A 36M)
2. Unheaded Rods: ASTM A 572, Grade 50 (ASTM A 572M, Grade 345)
3. Unheaded Bolts: ASTM A 687, high strength
4. Headed Bolts: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel, hex-head bolts; and carbon-steel nuts.
5. Headed Bolts: ASTM A325 (ASTM A 325M), Type 1, heavy hex steel structural bolts and heavy hex carbon-steel nuts.
6. Headed Bolts: ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts and heavy hex carbon-steel nuts.
7. Washers: ASTM A 36 (ASTM A 36M)

G. Nonhigh-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A (ASTM F 58, Property Class 4.6); carbon-steel, hex-head bolts; carbon-steel nuts; and flat, unhardened steel washers.

1. Finish: Plain, uncoated
2. Finish: Hot-dip zinc-coating, ASTM A 153, Class C
3. Finish: Mechanically deposited zinc-coating, ASTM B 695, Class 50

H. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain, uncoated
2. Finish: Hot-dip zinc-coating, ASTM A 153, Class C
3. Finish: Mechanically deposited zinc-coating, ASTM B 695, Class 50, epoxy coated

4. Direct-Tension Indicators: ASTm F 959, Type 325
   a. Finish: Plain, uncoated
   b. Finish: Mechanically deposited zinc-coating, ASTM B 695, Class 50
   c. Finish: Mechanically deposited zinc-coating, ASTM B 695, Class 50, epoxy coated

I. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers, uncoated.

1. Direct-Tension Indicators: ASTM F 959, Type 490 uncoated

J. Welding Electrodes: Comply with AWS requirements.

2.3 PRIMER

A. Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664.

B. Primer: SSPC-Paint 23, latex primer.

C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

2.4 GROUT

A. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean, uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic Shrinkage Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with ASTM C 1107 of consistency suitable for application, and a 30 minute working time.

2.5 FABRICATION

A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.

1. Properly mark and match mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.

2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

B. Connections: Weld or bolt shop connections, as indicated.

C. Bolt field connections, except where welded connections or other connections are indicated.

1. Provide high strength threaded fasteners for principal bolted connections, except where unfinished bolts are indicated.

2. Provide unfinished threaded fasteners for only bolted connections of secondary framing members to primary members (including purlins, girts, and other framing members taking only nominal stresses) and for temporary bracing to facilitate erection.

D. High Strength Bolted Construction: Install high strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts."

E. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.

F. Assemble and weld built up sections by methods that will produce true alignment of axes without warp.

G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld shear connectors in field, spaced as shown, to beams and girders in composite construction. Use automatic end welding of headed stud shear connectors in accordance with manufacturer's printed instructions.

H. Steel Wall Framing: Select members that are true and straight for fabrication of steel wall framing. Straighten as required to provide uniform, square, and true members in completed wall framing.

I. Build up welded door frames attached to structural steel framing. Weld exposed joints continuously and grind smooth. Plug weld steel bar stops to frames, except where shown removable. Secure removable stops to frames with countersunk, cross recessed head machine screws, uniformly spaced not more than 10 inches on center, unless otherwise indicated.

J. Holes for Other Work: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on final shop drawings.

K. Provide threaded nuts welded to framing and other specialty items as indicated to receive other work.

L. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

M. Expansion Joints: Provide expansion joints in steel shelf angles when part of structural steel frame; locate at vertical brick expansion joints as indicated on drawings.

2.6 SHOP PAINTING

A. Shop paint structural steel, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel that is partially exposed on exposed portions and initial 2 inches of embedded areas only.

1. Do not paint surfaces to be welded or high strength bolted with friction type connections.

2. Do not paint surfaces scheduled to receive sprayed on fireproofing.

3. Apply 2 coats of paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

B. Surface Preparation: After inspection and before shipping, clean steelwork to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) as follows:

1. SP 2 "Hand Tool Cleaning"

2. SP 3 "Power Tool Cleaning"

3. SP 6 "Commercial Blast Cleaning"

4. SP 7 "Brush Off Blast Cleaning"

5. SP 10 "Near White Blast Cleaning"

C. Painting: Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 1.5 mils. Use painting methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.7 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel indicated for galvanizing according to ASTM A 123.

2.8 SOURCE QUALITY CONTROL

A. Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

1. Promptly remove and replace materials or fabricated components that do not comply.

B. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at the Project Site whenever possible without causing delay in the work.

1. Promptly notify Owner whenever design of members and connections for any portion of structure are not clearly indicated.

PART 3 - EXECUTION

3.1 ERECTION

A. Surveys: Employ a licensed land surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Owner. Do not proceed with erection until corrections have been made or until compensating adjustments to structural steel work have been agreed upon with Owner.

B. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.

C. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.

1. Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.

2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.

3. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.

4. For proprietary grout materials, comply with manufacturer's instructions.

D. Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

E. Level and plumb individual members of structure within specified AISC tolerances.

F. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.

G. Splice members only where indicated and accepted on shop drawings.

H. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.

1. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Do not enlarge unfair holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

I. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members that are not under stress, as acceptable to Owner. Finish gas cut sections equal to a sheared appearance when permitted.

J. Touch Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

1. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.

3.2 QUALITY CONTROL

A. Owner will engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports. Testing agency shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations there from. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.

1. Testing agency shall comply with all the regulations of the Department of Public Works of the City of Houston and shall certify in writing, upon completion of the Work, that all Work was performed in accordance with the construction documents and all applicable city ordinances.

B. Testing agency shall conduct and interpret tests, state in each report whether test specimens comply with requirements, and specifically state any deviations there from.

C. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.

D. Testing agency may inspect structural steel at plant before shipment; however, Owner reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

E. Correct deficiencies in structural steel work that inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as necessary to reconfirm any noncompliance of original work and to show compliance of corrected work.

F. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

G. Field-bolted connections will be tested and inspected according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2

H. In addition to visual inspection, field-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's options.

1. Liquid Penetrant Inspection: ASTM E 165

2. Magnetic Particle Inspection: ASTM E 709; performed on roof pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T"

4. Ultrasonic Inspection: ASTM E 164

I. In addition to visual inspection, field-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:

1. Bend tests will be performed when visual inspections reveal either less than a continuous 360 degree flash or welding repairs to any shear connector.

2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

3.3 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

1. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils (0.038 mm).

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.

END OF SECTION 05 12 00 00

SECTION 05 12 23 00 - STRUCTURAL STEEL FOR BUILDINGS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for structural steel. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Structural steel.
      b. Prefabricated building columns.
      c. Grout.

C. Definitions
   1. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
   2. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
   3. Heavy Sections: Rolled and built-up sections as follows:
      a. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
      b. Welded built-up members with plates thicker than 2 inches (50 mm).
      c. Column base plates thicker than 2 inches (50 mm).
   4. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
   5. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

D. Performance Requirements
   1. Connections: Provide details of connections **OR** simple shear connections, **as directed**, required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified professional engineer, **as directed**, to withstand loads indicated and comply with other information and restrictions indicated.
      a. Select and complete connections using schematic details indicated and AISC 360.
      b. Use LRFD; data are given at factored-load level **OR** ASD; data are given at service-load level, **as directed**.
   2. Moment Connections: Type PR, partially **OR** FR, fully, **as directed**, restrained.
   3. Construction: Moment frame **OR** Braced frame **OR** Shear wall system **OR** Combined system of moment frame and braced frame **OR** Combined system of moment frame and shear walls **OR** Combined system of braced frame and shear walls **OR** Combined system of moment frame, braced frame, and shear walls, **as directed**.

E. Submittals
   1. Product Data: For each type of product indicated.
   2. LEED Submittal:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

3. Shop Drawings: Show fabrication of structural-steel components.
    a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
    b. Include embedment drawings.
    c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
    d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
    e. Identify members and connections of the seismic-load-resisting system.
    f. Indicate locations and dimensions of protected zones.
    g. Identify demand critical welds.
    h. For structural-steel connections indicated to comply with design loads, include structural design data signed and sealed by the qualified professional engineer responsible for their preparation, **as directed**.
4. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing **OR** qualified by testing, **as directed**, including the following:
    a. Power source (constant current or constant voltage).
    b. Electrode manufacturer and trade name, for demand critical welds.
5. Qualification Data: For qualified Installer **OR** fabricator **OR** professional engineer **OR** testing agency, **as directed**.
6. Welding certificates.
7. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
8. Mill test reports for structural steel, including chemical and physical properties.
9. Product Test Reports: For the following:
    a. Bolts, nuts, and washers including mechanical properties and chemical analysis.
    b. Direct-tension indicators.
    c. Tension-control, high-strength bolt-nut-washer assemblies.
    d. Shear stud connectors.
    e. Shop primers.
    f. Nonshrink grout.
10. Source quality-control reports.

F. Quality Assurance
1. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
2. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE **OR** CSE, **as directed**.
3. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 **OR** P2 **OR** P3, **as directed**, or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
4. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
    a. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
5. Comply with applicable provisions of the following specifications and documents:
    a. AISC 303.
    b. AISC 341 and AISC 341s1.
    c. AISC 360.
    d. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
6. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

1. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
    a. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
2. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
    a. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
    b. Clean and relubricate bolts and nuts that become dry or rusty before use.
    c. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

H. Coordination
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.2 PRODUCTS

A. Structural-Steel Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 50, **as directed**, percent.
   OR
   Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
    a. W-Shapes: 60 percent.
    b. Channels, Angles, M **OR** S, **as directed**,-Shapes: 60 percent.
    c. Plate and Bar: 25 percent.
    d. Cold-Formed Hollow Structural Sections: 25 percent.
    e. Steel Pipe: 25 percent.
    f. All Other Steel Materials: 25 percent.
2. W-Shapes: ASTM A 992/A 992M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345) **OR** ASTM A 913/A 913M, Grade 50 (345), **as directed**.
3. Channels, Angles, M **OR** S, **as directed**,-Shapes: ASTM A 36/A 36M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345) **OR** ASTM A 913/A 913M, Grade 50 (345), **as directed**.
4. Plate and Bar: ASTM A 36/A 36M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345), **as directed**.
5. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50 (345).
6. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B **OR** C, **as directed**, structural tubing.
7. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.
8. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
    a. Weight Class: Standard **OR** Extra strong **OR** Double-extra strong, **as directed**.
    b. Finish: Black **OR** Galvanized **OR** Black except where indicated to be galvanized, **as directed**.
9. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.

10. Steel Forgings: ASTM A 668/A 668M.
11. Welding Electrodes: Comply with AWS requirements.

B. Bolts, Connectors, And Anchors
1. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
   a. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
2. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends, **as directed**; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.
   a. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.
3. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
   a. Finish: Hot-dip zinc coating **OR** Mechanically deposited zinc coating, **as directed**.
   b. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating **OR** mechanically deposited zinc coating, baked epoxy-coated, **as directed**, finish.
4. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex **OR** round, **as directed**, head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   a. Finish: Plain **OR** Mechanically deposited zinc coating, **as directed**.
5. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
6. Unheaded Anchor Rods: ASTM F 1554, Grade 36 **OR** ASTM F 1554, Grade 55, weldable **OR** ASTM A 354 **OR** ASTM A 449 **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 36/A 36M, **as directed**.
   a. Configuration: Straight **OR** Hooked, **as directed**.
   b. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   c. Plate Washers: ASTM A 36/A 36M carbon steel.
   d. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
   e. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
7. Headed Anchor Rods: ASTM F 1554, Grade 36 **OR** ASTM F 1554, Grade 55, weldable **OR** ASTM A 354 **OR** ASTM A 449, **as directed**, straight.
   a. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   b. Plate Washers: ASTM A 36/A 36M carbon steel.
   c. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
   d. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
8. Threaded Rods: ASTM A 36/A 36M **OR** ASTM A 193/A 193M, Grade B7 **OR** ASTM A 354, Grade BD **OR** ASTM A 449 **OR** ASTM A 572/A 572M, Grade 50 (345), **as directed**.
   a. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   b. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened **OR** ASTM A 36/A 36M, **as directed**, carbon steel.
   c. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
9. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
10. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
11. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

12. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
    a. Mating Surfaces: PTFE and PTFE **OR** PTFE and mirror-finished stainless steel, **as directed**.
    b. Coefficient of Friction: Not more than 0.03 **OR** 0.04 **OR** 0.05 **OR** 0.06 **OR** 0.10 **OR** 0.12, **as directed**.
    c. Design Load: Not less than 2,000 psi (13.7 MPa) **OR** 5,000 psi (34 MPa) **OR** 6,000 psi (41 MPa), **as directed**.
    d. Total Movement Capability: 2 inches (50 mm).

C. Primer

1. Primer: Comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.

   OR

   Primer: SSPC-Paint 25, Type **I** **OR** Type **II**, **as directed**, zinc oxide, alkyd, linseed oil primer.

   OR

   Primer: SSPC-Paint 25 BCS, Type **I** **OR** Type **II**, **as directed**, zinc oxide, alkyd, linseed oil primer.

   OR

   Primer: SSPC-Paint 23, latex primer.

   OR

   Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat, **as directed**.
2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 **OR** ASTM A 780, **as directed**.

D. Grout

1. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
2. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

E. Fabrication

1. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
    a. Camber structural-steel members where indicated.
    b. Fabricate beams with rolling camber up.
    c. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
    d. Mark and match-mark materials for field assembly.
    e. If shop priming is required, complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
2. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
    a. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
3. Bolt Holes: Cut, drill, mechanically thermal cut, **as directed**, or punch standard bolt holes perpendicular to metal surfaces.
4. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
5. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" **OR** SSPC-SP 2, "Hand Tool Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning", **as directed**.
6. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

7. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
8. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.
9. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
    a. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning, **unless directed otherwise**.
    b. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
    c. Weld threaded nuts to framing and other specialty items indicated to receive other work.

F. Shop Connections
1. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
    a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
    a. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

G. Prefabricated Building Columns
1. Prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.
2. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.
    a. Fire-Resistance Rating: 4 hours **OR** 3 hours **OR** 2 hours **OR** As indicated, **as directed**.

H. Shop Priming
1. If shop priming is required, shop prime steel surfaces except the following:
    a. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
    b. Surfaces to be field welded.
    c. Surfaces to be high-strength bolted with slip-critical connections.
    d. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
    e. Galvanized surfaces.
2. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
    a. SSPC-SP 2, "Hand Tool Cleaning."
    b. SSPC-SP 3, "Power Tool Cleaning."
    c. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
    d. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
    e. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
    f. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    g. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
    h. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
    i. SSPC-SP 8, "Pickling."
3. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5

mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

- a. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- b. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

4. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

I. Galvanizing

1. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
    - a. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
    - b. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.

J. Source Quality Control

1. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
    - a. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
2. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
3. Bolted Connections: Shop-bolted connections will be inspected **OR** tested and inspected, **as directed**, according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
4. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E 165.
    - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    - c. Ultrasonic Inspection: ASTM E 164.
    - d. Radiographic Inspection: ASTM E 94.
5. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
    - a. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
    - b. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

1.3 EXECUTION

A. Examination

1. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
    - a. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in

intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

- a. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

C. Erection

1. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
2. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
    - a. Set plates for structural members on wedges, shims, or setting nuts as required.
    - b. Weld plate washers to top of baseplate.
    - c. Snug-tighten **OR** Pretension, **as directed**, anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
    - d. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts, **as directed**.
3. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
4. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
    - a. Level and plumb individual members of structure.
    - b. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
5. Splice members only where indicated.
6. Do not use thermal cutting during erection unless approved by UT Health. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
7. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
8. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

D. Field Connections

1. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
    - a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
    - a. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
    - b. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
    - c. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

E. Prefabricated Building Columns

1. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

F. Field Quality Control

1. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
2. Bolted Connections: Bolted connections will be inspected **OR** tested and inspected, **as directed**, according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
3. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
    a. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
        1) Liquid Penetrant Inspection: ASTM E 165.
        2) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
        3) Ultrasonic Inspection: ASTM E 164.
        4) Radiographic Inspection: ASTM E 94.
4. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
    b. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.
5. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

G. Repairs And Protection

1. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
2. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

    OR

    Touchup Painting: Cleaning and touchup painting are specified in Division 07.

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SECTION 05 21 00 00 – STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing joists similar to those indicated for this Project and that have a record of successful in-service performance.

   1. Manufacturer must be certified by SJI to manufacture joists conforming to SJI standard specifications and load tables.

B. SJI Design Standard: Comply with recommendations of SJI's "Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Griders," applicable to types of joists indicated.

1.01.1.1.3 Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code - Steel" and AWS D13 "Structural Welding Code - Sheet Steel."

   1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

C. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of joists that are similar to those indicated for this Project in material, design, and extent.

1.4 SUBMITTALS

A. Product Data:

   1. Product data and installation instructions for each type of joist and accessories.

      a. Include manufacturer's certification that joists comply with SJI "Specifications."

B. Record Documents:

   1. Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

   2. Shop drawings showing layout of joist members, special connections, joining and accessories. Include mark, number, type, location and spacing of joists and bridging.

      a. Provide templates or location drawings for installation of anchor bolts and metal bearing plates.

1.01.1.1.3.1.1 VOC compliance certificate signed by manufacturers certifying compliance of their products with regulations of authorities having jurisdiction over volatile organic compounds (VOCs).

1.5 DELIVERY, STORAGE and HANDLING

A. Deliver, store and handle steel joists as recommended in SJI "Specifications." Handle and store joists in a manner to avoid deforming members and to avoid excessive stresses.

1.6 PERFORMANCE REQUIREMENTS

A. Structural Performance: Engineer, fabricate, and erect joists and connections to withstand design loads within limits and under conditions required.

1. Design Loads: As indicated.

2. Design Joist to withstand design loads without deflections greater than the following:

a. Floor Joists: Vertical deflection of 1/360 of the span

b. Roof Joists: Vertical deflection of 1/240 of the span

c. Roof Joists: Vertical deflection of 1/360 of the span

B. Engineering Responsibility: Engage a joist manufacturer who utilizes a qualified professional engineer to prepare design calculations, shop drawings, and other structural data for steel joists.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 MATERIALS

A. Steel: Comply with SJI "Specifications" for chord and web sections.

1.01.1.1.4 Steel Bearing Plates: ASTM A 36

B. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.

1. Finish: Plain, noncoated

2. Finish: Hot-dip zinc coating, ASTM A 153, Class C

3. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50

C. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain, noncoated

2. Finish: Hot-dip zinc coating, ASTM A 153, Class C

3. Finish Mechanically deposited zinc coating, ASTM B 695, Class 50

D. Welding Electrodes: Comply with AWS standards.

1.01.1.1.5 Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

2.3 PRIMERS

A. Primer: SSPC-Paint 15, Type I, red oxide; Federal Specification TT-P-636, red oxide; or manufacturer's standard shop primer meeting the performance requirements of either of these red-oxide primers.

1.01.1.1.6 Primer: Fast-curing, lead- and chromate-free, VOC-compliant, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664.

2.4 FABRICATION

A. Fabricate steel joists in accordance with SJI "Specification."

1.01.1.1.7 Holes in Chord Members: Provide holes in chord members where shown for securing other work to steel joists; however, deduct area of holes from the area of chord when calculating strength of member.

B. Extended End: Provide extended ends on joists where indicated, complying with SJI "Specifications" and load tables.

1.01.1.1.8 Ceiling Extension: Provide ceiling extensions in areas having ceilings attached directly to joist bottom chord. Provide either an extended bottom chord element or a separate unit, to suit manufacturer's standards, of sufficient strength to support ceiling construction. Extend ends to within 1/2 inch of finished wall surface, unless otherwise indicated.

C. Top Chord Extension: Provide top chord extensions ("S" type) on joists where indicated, complying with SJI "Specifications" and load tables.

1.01.1.1.9 Bridging: Provide horizontal or diagonal type bridging for joists complying with SJI "Specifications."

1. Provide bridging anchors for ends of bridging lines terminating at walls or beams.

D. End Anchorage: Provide end anchorages, including steel bearing plates, to secure joists to adjacent construction, complying with SJI "Specifications."

1.01.1.1.10 Header Units: Provide header units to support tail joists at openings in floor or roof system not framed with steel shapes.

2.5 SHOP PAINTING

A. Do not shop paint joists to receive fireproofing.

1.01.1.1.11 Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories to be primed as follows: Surface Preparation; Power tool cleaning, SSPC-SP 3.

B. Apply one shop coat of primer to joists and joist accessories to be primed to provide a continuous, dry paint film thickness of not less than 1 mil (0.025 mm).

PART 3 - EXECUTION

3.1 ERECTION

A. Place and secure steel joists in accordance with SJI "Specifications," final shop drawings, and as herein specified.

1.01.1.1.12 Anchors: Furnish anchor bolts, steel bearing plates, and other devices to be built into concrete and masonry construction.

1. Provide unfinished threaded fasteners for anchor bolts, unless high strength bolts indicated.

B. Placing Joists: Do not start placement of steel joists until supporting work is in place and secured. Place joists on supporting work, adjust and align in accurate locations and spacing before permanently fastening.

1.01.1.1.13 Provide temporary bridging, connections, and anchors to ensure lateral stability during construction.

1. Where "open web" joist lengths are 40 feet and longer, install a center row of bolted bridging to provide lateral stability before slackening of hoisting lines.

C. Bridging: Install bridging simultaneously with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams.

1.01.1.1.14 Fastening Joists: Comply with the following:

1. Field weld joists to supporting steel framework and steel bearing plates where indicated in accordance with SJI "Specifications" for type of joists used. Coordinate welding sequence and procedure with placing of joists.

2. Bolt joists to supporting steel framework in accordance with SJI "Specifications" for type of joists used.

   a. Use unfinished threaded fasteners for bolted connections, unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: A qualified independent testing agency employed and paid by Owner will perform field quality-control testing.

1.01.1.1.15 Testing agency will report test results promptly and in writing to Contractor and Owner.

B. Testing and verification procedures will be required of high-strength bolted connections and field welds.

1. Bolted connections will be visually inspected

2. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."

3. Field-bolted connections will be tested and verified according to procedures in RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."

4. Field welds will be visually inspected

5. In addition to visual inspection, field welds will be inspected and tested according to AWS D1.1 and the following procedures:

   a. Radiographic Testing: ASTM E 94 and ASTM E 142

   b. Magnetic Particle Inspection: ASTM E 709

   c. Ultrasonic Testing: ASTM E 164

   d. Liquid Penetrant Inspection: ASTM E 165

C. Correct deficiencies in Work that inspections and test reports have indicated are not in compliance with specified requirements.

1.01.1.1.16 Additional testing will be performed to determine compliance of corrected Work with specified requirements.

3.3 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and the manufacturer's instructions.

1.01.1.1.17 Touch Up Painting: Following installation, promptly clean, prepare, and prime or re-prime field connections, rust spots and abraded surfaces of prime-painted joists, accessories, bearing plates, and abutting structural steel.

1. Clean and prepare surface by hand tool cleaning, SSPC-SP 2, or power tool cleaning, SSPC SP 3.

2. Apply and compatible primer of the same type as the shop primer used on adjacent surface.

1.01.1.1.17.1 INSTALLATION

B. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.18 All installation shall be in accordance with manufacturer’s published recommendations.

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SECTION 05 31 00 00 - STEEL DECKING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. American Iron and Steel Institute (AISI), "Specification for the Design of Cold Formed Steel Structural Members."
2. American Welding Society (AWS), D1.3 "Structural Welding Code Sheet Steel."
3. Steel Deck Institute (SDI), "Design Manual for Composite Decks, Form Decks and Roof Decks."

1.03 QUALITY ASSURANCE

A. Qualification of Field Welding: Use qualified welding processes and welding operators in accordance with "Welder Qualification" procedures of AWS.

1. Welded decking in place is subject to inspection and testing. Owner will bear expense of removing and replacing portions of decking for testing purposes if welds are found to be satisfactory. Remove work found to be defective and replace with new acceptable work.

B. Underwriters' Label: Provide metal floor deck units listed in Underwriters' Laboratories "Fire Resistance Directory", with each deck unit bearing the UL label and marking for specific system detailed.

1. Provide cellular floor deck units listed in UL "Electrical Construction Materials Directory" with each cellular metal floor deck unit bearing UL labels and marking. Provide units that will permit use of standard header ducts and outlets for electrical distribution systems.

C. FM Listing: Provide steel roof deck units that have been evaluated by Factory Mutual System and are listed in "Factory Mutual Approval Guide" for "Class I" fire rated construction.

1.04 SUBMITTALS

A. Product Data:

1. Product data including manufacturer's specifications and installation instructions for each type of decking and accessories.
    a. Provide test data for mechanical fasteners used in lieu of welding for fastening deck to supporting structures.

B. Shop Drawings:

1. Showing layout and types of deck units, anchorage details, and conditions requiring closure strips, supplementary framing, sump pans, cant strips, cut openings, special jointing, and other accessories.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include:

1. American Building Co.
2. ASC Pacific, Inc.
3. Bowman Metal Deck Div., Cyclops Corp.
4. Consolidated Systems, Inc.
5. Epic Metals Corp.
6. Marlyn Steel Products, Inc.
7. H. H. Robertson Co.
8. Roof Deck, Inc.
9. United Steel Deck, Inc.
10. Verco Manufacturing Co.
11. Vulcraft Div., Nucor Corp.
12. Walker.
13. Wheeling Corrugating Co.

2.03 ROOF DECK

A. Steel Roof Deck: Fabricate panels without top-flange stiffening groves conforming to SDI Publication No. 28" Specifications and Commentary for Steel Roof Deck" and the following:

1. Galvanized-Steel Sheet: ASTM A 446 Grade A, G 60 (ASTM A 446M, Grade A, Z 180) zinc coated according to ASTM A 525 (ASTM A 525M).

2. Galvanized-Steel Sheet: ASTM A 446 Grade A, G 90 (ASTM A 446M, Grade A, Z 275) zinc coated according to ASTM A 425 (ASTM A 525M).

B. Acoustical Steel Roof Deck: Fabricate panels without top-flange stiffening grooves conforming to SDI Publication No. 28 "Specifications and Commentary for Steel Roof Deck" and the following:

1. Galvanized-Steel Sheet: ASTM A 446, Grade A, G 60 (ASTM A 446M, Grade A, Z 180) zinc coated according to ASTM A 525 (ASTM A 525M).

2. Galvanized-Steel Sheet: ASTM A 446, Grade A, G 90 (ASTM A 446M, Grade A, Z 275) zinc coated according to ASTM A 525 (ASTM A 525M).

3. Acoustical Perforations and Sound Insulation: Deck panels with manufacturer's standard perforated vertical webs.

4. Acoustical Perforations and Sound Insulation: Cellular deck panels with manufacturer's standard perforated flat-bottom plate welded to ribbed deck.

2.04 FLOOR DECK

A. Composite Steel Floor Deck: Fabricate panels with integrally embossed or raised pattern ribs and interlocking side laps, conforming to SDI Publication No. 28 "Specifications and Commentary for Composite Steel Floor Deck," the minimum section properties indicated, and the following:

1. Galvanized-Steel Sheet: ASTM A 446, Grade A, G 60 (ASTM A 446M, Grade A, Z 180) zinc coated according to ASTM A 525 (ASTM A 525M).

2. Galvanized-Steel Sheet: ASTM A 446, Grade A, G 90 (ASTM A 446M, Grade A, Z 275) zinc coated according to ASTM A 525 (ASTM A 525M).

B. Cellular Metal Floor Deck for Electrical Distribution:

1. Fabricate steel sheet cellular floor deck panels composed of a ribbed top section welded to a lower flat-bottom sheet with interlocking side laps conforming to SDI Publication No. 28 "Specifications and Commentary for Cellular Metal Floor Deck with Electrical Distribution."

2. Fabricate deck to the minimum section properties, width of panel, number and area of cells per panel indicated, and the following:

   a. Deck Type: Composite

   b. Deck Type: Noncomposite

3. Galvanized-Steel Sheet: ASTM A 446, Grade A, G 60 (ASTM A 446M, Grade A, Z 180) zinc coated according to ASTM A 525 (ASTM A 525M)

4. Galvanized-Steel Sheet: ASTM A 446, Grade A, G 90 (ASTM A 446M, Grade A, Z 275) zinc coated according to ASTM A 525 (ASTM A 525M)

5. Galvanized and Shop-Primed Steel Sheet: ASTM A 446, Grade A, G 60 (ASTM A 446M, Grade A, Z 180) zinc coated according to ASTM A 525 (ASTM A 525M); cleaned, pretreated, and primed with manufacturer's baked-on, lead- and chromate-free rust-inhibitive primer.

6. Shop punch holes of size and arrangement recommended by deck manufacturer, into each cell of the deck at preset inserts and harder duct locations.

7. Shop punch holes, of size and arrangement indicated, into each cell of the deck at preset inserts and header duct locations.

2.05 FORM DECK

A. Noncomposite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form deck panels conforming to SDI Publication No. 28 "Specifications and Commentary for Noncomposite steel form Deck", the minimum section properties indicated, and the following:

   1. Galvanized-Steel Sheet: ASTM A 446, Grade E, G 60 (ASTM A 446M, Grade E, Z 180) zinc coated according to ASTM A 525 (ASTM A 525M)

   2. Galvanized-Steel Sheet: ASTM A 446, Grade E, G 90 (ASTM A 446M, Grade E, Z 275) zinc coated according to ASTM A 525 (ASTM A 525M)

B. Vented Noncomposite Steel Form Deck: Fabricate ribbed- and vented-steel sheet noncomposite form deck panels conforming to SDI Publication No. 28 "Specifications and Commentary for Noncomposite Steel Form Deck," and the following:

   1. Galvanized-Steel Sheet: ASTM A 446, Grade E, G 60 (ASTM A446M, Grade E, Z 180) zinc coated according to ASTM A 525 (ASTM A 525M)

   2. Galvanized-Steel Sheet: ASTM A 446, Grade E, G 90 (ASTM A 446M, Grade E, Z 275) zinc coated according to ASTM A 525 (ASTM A 525M)

   3. Vent Slot Area: Manufacturer's standard vent slots providing 1.5 percent minimum open area.

2.06 ACCESSORIES

A. Provide accessory materials for steel deck that comply with requirements indicated and recommendations of the steel deck manufacturer.

B. Mechanical Fasteners: Manufacturer's standard, corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon steel fasteners; or self-drilling, self-threading screws.

C. Side Lap Fasteners: Manufacturer's standard, corrosion-resistant, hexagonal washer head; self-drilling, carbon steel screws, No. 10 (4.8 mm) minimum diameter.

D. Rib Closure Strip: Manufacturer's standard vulcanized, closed-cell, synthetic rubber.

E. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip glass fiber or mineral fiber.

F. Miscellaneous Roof Deck Accessories: Steel sheet, 0.0359-inch- (0.91-mm) thick minimum ridge and valley plates, finish strips, and reinforcing channels, of same material as roof deck.

G. Pour Stops and Girder Fillers: Steel sheet, of same material as deck panels, and of thickness and profile indicated.

H. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material and thickness as deck panels, unless otherwise indicated.

I. Hanger Tabs: Manufacturer's standard piercing steel sheet hanger attachment devices for floor deck panels.

J. Weld Washers: Manufacturer's standard uncoated-steel sheet weld washers, shaped to fit deck rib, 0.0598 inch (1.5 mm) thick with 3/8-inch (9.5-mm) minimum diameter prepunched hole.

K. Recessed Sump pans: Manufacturer's standard size, single piece steel sheet 0.071-inch- (1.8mm-) thick minimum, of same material as deck panels, with 1-1/2-inch- (38-mm-) minimum deep level recessed pans and 3-inch- (76-mm-) wide flanges. Cut holes for drains in the field.

L. Flat Receiver Pan: Manufacturer's standard size, single-piece steel sheet, 0.071-inch- (1.8-mm-) thick minimum units, of same material as deck panels. Cut holes for drains in the field.

M. Shear Connectors: ASTM A 108, Grade 1010 through 1020 headed stud type, cold-finished carbon steel, AWS D1.1, Type b.

N. Steel Sheet Accessories: ASTM A 446, G 60 (ASTM A 446M, Z 180) coating class, galvanized according to ASTM A 525 (ASTM A 525M).

O. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

P. Preset Inserts: Manufacturer's standard, UL-labeled single-piece preset inserts, fabricated from either still sheet galvanized according to ASTM A 525, G 60 (ASTM A 525M, Z 180) coating class, or zinc sheet, with removable covers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install deck units and accessories in accordance with manufacturer's recommendations, shop drawings, and as specified herein.

D. Place deck units on supporting steel framework and adjust to final position with ends accurately aligned and bearing on supporting members before being permanently fastened. Do not stretch or contract side lap interlocks.

E. Align deck units for entire length of run of cells and with close alignment between cells at ends of abutting units.

F. Place deck units flat and square, secured to adjacent framing without warp or deflection.

G. Do not place deck units on concrete supporting structure until concrete has cured and is dry.

H. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.

I. Do not use deck units for storage or working platforms until permanently secured.

3.02 ROOF DECK INSTALLATION

A. Fasten roof deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter, but not less than 1-1/2 inches (38 mm) long, and as follows:

1. Weld Diameter: 5/8 inch (16 mm), nominal
2. Weld Diameter: 3/4 inch (19 mm), nominal
3. Weld Spacing: Weld edge ribs of panels at each support. Space welds an average of 12 inches (305 mm) apart, with a minimum of two welds per unit at each support.
4. Weld Spacing: Space and locate welds as indicated
5. Weld Washers: Where deck thickness is less than 0.028 inches, install weld washers at each weld location.

B. Side Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding 36 inches (910 mm), using one of the following methods:

1. Mechanically fasten with self-drilling No. 10 - (4.8-mm-) diameter or larger carbon steel screws.
2. Mechanically clinch or bottom punch
3. Fasten with 1-1/2-inch- (38-mm-) long minimum welds.

C. End Bearing: Install deck ends over supporting framing with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped 2 inches (51 mm) minimum
2. End Joints: Butted
3. End Joints: Lapped 2 inches (51 mm) minimum or butted at Contractor's option

D. Roof Sump Pans and Sump Plates: Install over openings provide in roof decking, and weld flanges to top of deck. Space welds not more than 12 inches (305 mm) apart with at least one weld at each corner.

E. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's recommendations. Weld to substrate to provide a complete deck installation.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's instructions to ensure complete closure.

G. Sound-Absorbing Insulation: Install premolded, roll or strip sound-absorbing insulation according to deck manufacturer's instructions.

3.03 FLOOR DECK INSTALLATION

A. Fasten floor deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter 5/8 inch (16 mm), nominal
2. Weld Diameter: 3/4 inch (19 mm), nominal
3. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inch (305 mm) apart, but not more than 18 inches (457 mm) apart.
4. Weld Spacing: Space and locate welds as indicated.
5. Weld Washers: Where deck thickness is less than 0.028 inches, install weld washers at each weld location.

B. Side Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports or at intervals not exceeding 36 inches (910 mm), using one of the following methods:

1. Mechanically fasten with self-drilling No. 10- (4.8-mm-) diameter or large carbon steel screws.
2. Mechanically clinch or bottom punch
3. Fasten with 1-1/2-inch- (38-mm-) long minimum welds.

C. End Bearing: Install deck ends over supporting framing with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped
2. End Joints: Butted
3. End Joints: Lapped or butted at Contractor's options

D. Shear Connectors: Weld shear connectors through deck to support framing according to AWS D1.1 and manufacturer's instructions. Butt end joints of dec panels; do not overlap.

E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

F. Floor Deck Closures: Weld steel column closures, cell closures, and Z-closures to deck according to SDI recommendations to provide tight-fitting closures at open ends of ribs and sides of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.

G. Maintain smooth cellular raceway interiors free of welds or mechanical fasteners.

H. Install piercing hanger tabs not more than 14 inches (355 mm) apart in both directions, within 9 inches (228 mm) of wall at ends, and not more than 12 inches (305 mm) from walls at sides, unless otherwise indicated.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: A qualified independent testing agency employed and paid by Owner will perform field quality-control testing.

B. Field welds will be subject to inspection.

C. Shear connector welds will be inspected and tested according to the requirements of AWS D1.1 for stud welding and as follows:

1. Shear connector welds will be visually inspected.
2. Blend tests will be performed when visual inspection reveal either less than a continuous 360 degree flash or welding repairs to any shear connector.
3. Test will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to the requirements of AWS D1.1.

D. Testing agency will report test results promptly and in writing to Contractor and Owner.

E. Remove and replace Work that does not comply with specified requirements.

F. Additional testing will be performed to determine compliance of corrected work with specified requirements.

3.05 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces with galvanized repair paint according to ASTM A 780 and the manufacturer's instructions.

B. Provide final protection and maintain conditions to ensure steel decking is without damage or deterioration at time of Substantial Completions.

END OF SECTION 05 31 00 0031 00

SECTION 05 40 00 00 – COLD FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Component Design: Calculate structural properties of studs and joists in accordance with American Iron and Steel Institute (AISI) "Specification for Design of Cold Formed Steel Structural Members."

1.01.1.1.3 Welding: Use qualified welders and comply with American Welding Society (AWS) D1.3, "Structural Welding Code Sheet Steel."

B. Fire Rated Assemblies: Where framing units are components of assemblies indicated for a fire resistance rating, including those required for compliance with governing regulations, provide units that have been approved by governing authorities that have jurisdiction.

1.4 SUBMITTALS

A. Product Data:

1. Product data and installation instructions for each item of cold formed metal framing and accessories

B. Record Documents:

1. Shop drawings for special components and installations not fully dimensioned or detailed in manufacturer's product data.

   a. Include placing drawings for framing members showing size and gage designations, number, type, location, and spacing. Indicate supplemental strapping, bracing, splices, bridging, accessories, and details required for proper installation.

1.5 performance requirements

A. AISI "Specification": Calculate structural characteristics of cold-formed metal framing according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members" and the following:

1.01.1.1.4 AISI "Specification": Calculate structural characteristics of cold-formed metal framing according to AISI's "Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members" and the following:

1. Center for Cold-Formed Steel Structures (CCFSS) Technical Bulletin, Vol. 2, No. 1, February 1993 "AISI Specification Provisions for Screw Connections."

B. Structural Performance: Engineer, fabricate and erect cold-formed metal framing with the following minimum physical and structural properties:

1. Physical and Structural Properties: As indicated.

C. Structural Performance: Engineer, fabricate, and erect cold-formed metal framing to withstand design loads within limits and under conditions required.

1. Design framing systems to withstand design loads without deflections greater than the following:

   a. Exterior Load-Bearing Walls: Lateral deflection of 1/360 of the wall height, unless otherwise indicated.

   b. Interior Load-Bearing Walls: Lateral deflection of 1/360 of the wall height.

   c. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/240 of the wall height.

   d. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/360 of the wall height.

   e. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/600 of the wall height.

   f. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/720 of the wall height.

   g. Floor Joists: Vertical deflection of 1/240 of the span.

   h. Floor Joists: Vertical deflection of 1/360 of the span.

   i. Roof Trusses: Vertical deflection of 1/240 of the span.

   j. Roof Trusses: Vertical deflection of 1/360 of the span.

   1.01.1.1.4.1.1 Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects with subject to a maximum ambient temperature change (range) of 120 degrees F (67 degrees C).

2. Design framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings.

D. Design exterior nonload-bearing curtainwall framing to accommodate lateral deflection without regard to contribution of sheathing materials.

1.01.1.1.5 Engineering Responsibility: Engage a fabricator who assumes undivided responsibility for engineering cold formed metal framing by employing a qualified professional engineer to prepare design calculations, shop drawings, and other structural data.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 acceptable manufacturers

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include:

1. Alabama Metal Industries Corp.
2. American Studco, Inc.
3. Dale/Incor, Industries of Florida
4. Dale Industries, Inc.
5. Dietrich Industries, Inc.
6. Incor Plant Dale Industries
7. Marino/Ware; Div. of Ware Industries, Inc.
8. Super Stud Building Products, Inc.
9. Unimast, Inc.
10. United Construction Supply
11. United States Steel

1.01.1.1.5.1 METAL FRAMING

B. System Components: Manufacturers' standard load bearing steel studs and joists of type, size, shape, and gage as indicated. With each type of metal framing required, provide manufacturer's standard, steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories for applications indicated, as needed to provide a complete metal framing system.

1.01.1.1.6 Materials and Finishes:

1. For 16 gage and heavier units, fabricate metal framing components of structural quality steel sheet with a minimum yield point of 40,000 psi; ASTM A 446, A 570, or A 611.

2. For 18 gage and lighter units, fabricate metal framing components of commercial quality steel sheet with a minimum yield point of 33,000 psi; ASTM A 446, A 570, or A 611.

3. Provide galvanized finish to metal framing components complying with ASTM A 525 for minimum G 60 coating.

   a. Where metal framing provides back-up support for brick veneer, provide G90 (Z275) coating.

   1.01.1.1.6.1.1 Prime-Painted Steel Sheet: ASTM A 570 (ASTM A 570M) or ASTM A 611, cleaned, pretreated, and primed with manufacturer's baked-on, lead- and chromate-free, rust-inhibitive prime conforming to the performance requirements of FS TT-P-664.

   b. Finish of installation accessories to match that of main framing components, unless otherwise indicated.

   1.01.1.1.6.1.2 Fasteners: Provide nuts, bolts, washers, screws, and other fasteners with corrosion resistant plated finish.

4. Electrodes for Welding: Comply with AWS Code and as recommended by stud manufacturer.

5. Galvanizing Repair: Where galvanized surfaces are damaged, prepare surfaces and repair in accordance with procedures specified in ASTM A 780.

1.01.1.1.6.2 FRAMING ACCESSORIES

C. Fabricate steel-framing accessories of the same material and finish used for framing members, with minimum yield strength of 33,000 psi (230 MPa).

1.01.1.1.7 Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, including:

1. Supplementary framing
2. Bracing, bridging, and solid blocking
3. Web stiffeners
4. Gusset plates
5. Deflection track and vertical slide clips
6. Reinforcement plates

1.01.1.1.7.1 ANCHORS, CLIPS, AND FASTENERS

D. Steel Shapes and Clips: ASTM A 36 (ASTM A 36M), zinc coated by the hot-dip process according to ASTM A 123.

1.01.1.1.8 Cast-in-Place Anchor Bolts and Studs: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel hex-head bolts and studs; carbon-steel nuts; and flat, unhardened-steel washers. Zinc coated by hot-dip process according to ASTM A 153.

E. Welding Electrodes: Comply with AWS standards.

2.3 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

1.01.1.1.9 Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and a 30-minute working time.

2.4 FABRICATION

A. Framing components may be prefabricated into assemblies before erection. Fabricate panels plumb, square, true to line, and braced against racking with joints welded. Perform lifting of prefabricated units to prevent damage or distortion.

1.01.1.1.10 Fabricate units in jig templates to hold members in proper alignment and position and to assure consistent component placement.

B. Fastenings: Attach similar components by welding. Attach dissimilar components by welding, bolting, or screw fasteners, as standard with manufacturer.

1.01.1.1.11 Wire tying of framing components is not permitted.

C. Fabrication Tolerances: Fabricate units to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet.

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 PREPARATION

A. Pre-Installation Conference:

1. Prior to start of installation of metal framing systems, meet at Project Site with installers of other work including door and window frames and mechanical and electrical work.

2. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.

1.01.1.1.11.1 INSTALLATION

B. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.12 All installation shall be in accordance with manufacturer’s published recommendations.

C. Install metal framing systems in accordance with manufacturer's printed or written instructions and recommendations.

1.01.1.1.13 Runner Tracks: Install continuous tracks sized to match studs. Align tracks accurately to layout at base and tops of studs. Secure tracks as recommended by stud manufacturer for type of construction involved, except do not exceed 24 inches on center spacing for nail or powder driven fasteners or 16 inches on center for other types of attachment. Provide fasteners at corners and ends of tracks.

D. Installation of Wall Studs: Secure studs to top and bottom runner tracks by either welding or screw fastening at both inside and outside flanges.

1.01.1.1.14 Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

E. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.

1.01.1.1.15 Install supplementary framing, blocking, and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations and industry standards in each case, considering weight or loading resulting from item supported.

F. Frame wall openings larger than two feet square with double stud at each jamb of frame except where more than two are either shown or indicated in manufacturer's instructions. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full height studs of wall. Secure stud system wall opening frame in manner indicated.

1.01.1.1.16 Frame both sides of expansion and control joints with separate studs; do not bridge the joint with components of stud system.

G. Install horizontal stiffeners in stud system, spaced (vertical distance) at not more than 54 inches on center. Weld at each intersection.

1.01.1.1.17 Erection Tolerances: Bolt or weld wall panels (at both horizontal and vertical junctures) to produce flush, even, true to line joints.

1. Maximum variation in plane and true position between prefabricated assemblies should not exceed 1/16 inch.

H. Installation of Joists: Install level, straight, and plumb, complete with bracing and reinforcing as indicated on drawings. Provide not less than 1-1/2 inch end bearing.

1.01.1.1.18 Reinforce ends with end clips, steel hangers, steel angle clips, steel stud section, or as otherwise recommended by joist manufacturer.

I. Where required, reinforce joists at interior supports with single short length of joist section located directly over interior support, snap on shoe, 30 percent side piece lapped reinforcement, or other method recommended by joist manufacturer.

1.01.1.1.19 Secure joists to interior support systems to prevent lateral movement of bottom flange.

J. Field Painting: Touch up damaged shop applied protective coatings. Use compatible primer for prime coated surfaces; use galvanizing repair system for galvanized surfaces.

END OF SECTION 05 40 00 00

SECTION 05 50 00 00 – METAL FABRICATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.

B. Installer Qualifications: Arrange for installation of metal fabrications specified in this section by same firm that fabricated them.

C. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code   Steel," D1.3 "Structural Welding Code   Sheet Steel", and D1.2 "Structural Welding Code   Aluminum."

  1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 SUBMITTALS

A. Product Data:

  1. Product data and installation instructions for each prefabricated item of miscellaneous metal fabrications and accessories.

  2. Samples representative of materials and finished products as may be requested by Owner.

1.01.1.1.1.1 Record Documents:

  3. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

    a. Where installed metal fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified professional engineer who was responsible for their preparation.

1.01.1.1.1.1.1 PROJECT CONDITIONS

B. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

   1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 FERROUS METALS

A. For metal fabrications exposed to view upon completion of the Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher leveled sheet.

B. Steel Plates, Shapes, and Bars: ASTM A 36.

C. Rolled Steel Floor Plates: ASTM A 786.

D. Steel Bars for Gratings: ASTM A 569 or ASTM A 36.

E. Wire Rod for Grating Cross Bars: ASTM A 510.

F. Steel Tubing: Product type (manufacturing method) and as follows:

   1. Cold Formed Steel Tubing: ASTM A 500, grade as indicated below:

      a. Grade A, unless otherwise indicated or required for design loading.

      b. For exterior installations and where indicated, provide tubing with hot dip galvanized coating per ASTM A 53.

G. Uncoated Steel Sheet: Commercial quality, product type (method of manufacture) as follows:

   1. Cold Rolled Steel Sheet: ASTM A 366

1.01.1.1.1.2 Galvanized Steel Sheet: Commercial Quality; ASTM A 526, G90 coating designation unless otherwise indicated.

H. Steel Pipe: ASTM A 53; finishand type as follows:

   1. Black finish, unless otherwise indicated.

   2. Galvanized finish for exterior installations and where indicated.

1.01.1.1.1.3 Gray Iron Castings: ASTM A 48, Class 30.

I. Malleable Iron Castings: ASTM A 47, grade 32510.

J. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

K. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers, and shims as required, hot dip galvanized per ASTM A 153.

L. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for the metal alloy to be welded.

2.3 STAINLESS STEEL

A. Bar Stock: ASTM A 276, Type 302 or 304.

B. Plate: ASTM A 167, Type 302 or 304.

2.4 ALUMINUM

A. Extruded Bars and Shapes: ASTM B 221, alloys 6063-T6:

B. Aluminum Alloy Rolled Tread Plate: ASTM B 632, alloys 6061-T6:

C. Aluminum Sheet for Expanded Aluminum Grating: ASTM B 209, alloy 5052 H32.

2.5 GROUT AND ANCHORING CEMENT

A. Nonshrink Nonmetallic Grout: Premixed, factory packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.

1. "B-6 Construction Grout"; W. R. Bonsal Co.
2. "Diamond Crete Grout"; Concrete Service Materials Co.
3. "Euco N S Grout"; Euclid Chemical Co.
4. "Masterflow 928 and 713"; Master Builders.
5. "Sealtight 588 Grout"; W. R. Meadows, Inc.
6. "Sonogrout 14"; Sonneborn Building Products.
7. "Stoncrete NM1"; Stonhard, Inc.
8. "Five Star Grout"; U. S. Grout Corp.
9. "Vibropruf #11"; Lambert Corp.

1.01.1.1.1.4 Interior Anchoring Cement: Factory prepackaged, nonshrink, nonstaining, hydraulic controlled expansion cement formulation for mixing with water at Project Site to create pourable anchoring, patching, and grouting compound. Use for interior applications only.

10. "Bonsal Anchor Cement"; W. R. Bonsal Co.
11. "Por Rok"; Minwax Construction Products Division.

1.01.1.1.1.5 Nonshrink Metallic Grout: Premixed, factory packaged, ferrous aggregate grout complying with ASTM C 1107 2, specifically recommended by manufacturer for heavy duty loading applications of type specified in this section.

12. "Metox RM"; Chem Masters Corp.
13. "Hi Mod Grout"; Euclid Chemical Co.
14. "Embeco 885 and 636"; Master Builders.

15. "Ferrolith G Redi Mix and G NC"; Sonneborn Building Products Div., Rexnord Chemical Products, Inc.

2.6 FASTENERS

A. Provide zinc coated fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.

B. Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.

C. Lag Bolts: Square head type, FS FF B 561.

D. Machine Screws: Cadmium plated steel, FS FF S 92.

E. Wood Screws: Flat head carbon steel, FS FF S 111.

F. Plain Washers: Round, carbon steel, FS FF W 92.

G. Drilled In Expansion Anchors: Expansion anchors complying with FS FF S 325, Group VIII (anchors, expansion, [nondrilling]), Type I (internally threaded tubular expansion anchor); and machine bolts complying with FS FF B 575, Grade 5.

H. Toggle Bolts: Tumble wing type, FS FF B 588, type, class, and style as required.

I. Lock Washers: Helical spring type carbon steel, FS FF W 84.

2.7 PAINT

A. Shop Primer for Ferrous Metal: Manufacturer's or fabricator's standard, fast curing, lead free, universal modified alkyd primer selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated, and for capability to provide a sound foundation for field applied topcoats despite prolonged exposure complying with performance requirements of FS TT P 645.

B. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD P 21035 or SSPC Paint 20.

C. Bituminous Paint: Cold applied asphalt mastic complying with SSPC Paint 12 except containing no asbestos fibers.

2.8 FABRICATION, GENERAL

A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

C. Allow for thermal movement resulting from 100 degrees F (55.5 degrees C) maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

D. Shear and punch metals cleanly and accurately. Remove burrs.

E. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Remove sharp or rough areas on exposed traffic surfaces.

G. Weld corners and seams continuously to comply with AWS recommendations and the following:

  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

  2. Obtain fusion without undercut or overlap.

  3. Remove welding flux immediately.

  4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.

1.01.1.1.1.6 Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat head (countersunk) screws or bolts. Locate joints where least conspicuous.

H. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

I. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

J. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.

K. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.9 ROUGH HARDWARE

A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 06 sections.

B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

2.10 STEEL LADDERS

A. Fabricate ladders for the locations shown, with dimensions, spacing, and anchorages as indicated. Unless otherwise indicated, fabricate ladders with component parts specified herein. Comply with requirements of ANSI A14.3.

B. Siderails: Continuous steel flat bars, 1/2 inch x 2 1/2 inches, with eased edges, spaced 18 inches apart.

C. Bar Rungs: Round steel bars, 3/4 inch diameter, spaced 12 inches on center.

D. Bar Rungs: Square steel bars, 3/4 inch, spaced 12 inches on center.

E. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.

F. Support each ladder at top and bottom and at intermediate points spaced not more than 5' 0" on center by means of welded or bolted steel brackets.

  1. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.

2. Extend side rails 42 inches above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose neck the extended rails back to the structure to provide secure ladder access.

1.01.1.1.1.7 Provide non slip surface on top of each rung, either by coating the rung with aluminum oxide granules set in epoxy resin adhesive, or by using a type of manufactured rung which is filled with aluminum oxide grout.

2.11 SHIP'S LADDERS

A. Provide ship's ladders where indicated. Fabricate of open type construction with structural steel channel or steel plate stringers, pipe handrails, and open steel grating treads, unless otherwise indicated. Provide all necessary brackets and fittings for installation.

B. Galvanize all ladders, including, brackets and fasteners.

2.12 ABRASIVE NOSINGS

A. Provide abrasive nosings on stair treads where indicated fabricated with an aluminum base and an aluminum oxide or silicone carbide abrasive filler.

1. Provide configuration of nosings as indicated and appropriate to the stair construction.
2. Size nosings to extend full width of concrete-filled steel pan treads and approximately 3 inches short of each end of concrete stair treads.
3. Provide color of filler as selected by Owner from manufacturer's standards; 8 choices minimum.

1.01.1.1.1.8 Product: Subject to compliance with requirements, provide "Supergrit Safety Nosings" by Wooster Products Inc., or equal product of one of the following:

4. Amstep Products
5. American Safety Tread Co.
6. Armstrong Products Inc.
7. Safe-T-Metal Co. Inc.

2.13 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

2.14 MISCELLANEOUS FRAMING AND SUPPORTS

A. Provide steel framing and supports for applications indicated or which are not parts of structural steel framework, as required to complete work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
    a. Except as otherwise indicated, space anchors 24 inches on center and provide minimum anchor units in the form of steel straps 1-1/4 inches wide x 1/4 inch x 8 inches long.

1.01.1.1.1.8.1 METAL BAR GRATINGS

C. Produce metal bar gratings of description indicated per NAAMM marking system that comply with the following:

1. Metal Bar Grating Standard "Standard Specifications for Metal Bar Grating and Metal Bar Grating Treads" published in ANSI/NAAMM A202.1 "Metal Bar Grating Manual."

2. Heavy Duty Metal Bar Grating Standard: "Guide Specifications for Heavy Duty Metal Bar Grating" published in NAAMM "Heavy Duty Metal Bar Grating Manual."

1.01.1.1.1.9 To establish standards of manufacturer, specification is based upon products of Reliance Steel Products, Inc. Subject to compliance with requirements, other manufacturers offering metal bar gratings that may be incorporated in the Work include, but are not limited to, the following:

3. Alabama Metal Industries Corp.

4. Barnett/Bates Corp.

5. Blaw Knox Grating Div., Blaw Knox Corp.

6. IKG Industries

7. Klemp Corp.

8. Ohio Gratings, Inc.

9. Seidelhuber Metal Products, Inc.

10. Trueweld, Inc.

1.01.1.1.1.10 Galvanized Steel Bar Grating: Provide Reliance Steel Products Company hot dipped galvanized steel "Type 3/4R4 Electro Pressure Welded" grating with 1-1/2 inch x ¼ inch bearing bars spaced at 1 inch centers and ½ inch x 3/16 inch rectangular cross bars spaced at 4 inch centers. Slot bearing bars for rectangular cross bars prior to electropressure welding. Provide banding bars of same size as bearing bars.

D. Prime Painted Steel Bar Grating: Provide Reliance Steel Products Company "Type 1R4 Electro Pressure Welded" grating with 1-1/2 inch x ¼ inch bearing bars spaced 1-1/4 inch centers and ½ inch x 3/16 inch rectangular cross bars spaced at 4 inch centers. Provide one shop coat Tnemec 10 99G (green) modified alkyd rust inhibitive primer as specified after fabrication.

2.15 STEEL PIPE RAILINGS AND HANDRAILS

A. Fabricate pipe railings and handrails to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of pipe, post spacings, and anchorage, but not less than that required to support structural loads.

B. Interconnect railing and handrail members by butt welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

1. At tee and cross intersections, notch ends of intersecting members to fit contour of pipe to which end is joined and weld all around.

1.01.1.1.1.11 Form changes in direction of railing members as follows:

2. By insertion of prefabricated elbow fittings.

3. By radius bends of radius indicated.

4. By mitering at elbow bends.

5. By bending.

6. By any method indicated above, applicable to change of direction involved.

1.01.1.1.1.12 Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.

C. Provide wall returns at ends of wall mounted handrails, unless otherwise indicated.

D. Close exposed ends of pipe by welding 3/16 inch thick steel plate in place or by use of prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is 1/4 inch or less.

E. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.

F. For exterior steel railings and handrails formed from steel pipe with galvanized finish, galvanize fittings, brackets, fasteners, sleeves, and other ferrous components.

G. For interior steel railings and handrails formed from steel pipe with galvanized finish, galvanize fittings, brackets, fasteners, sleeves, and other ferrous components.

H. For interior steel railings formed from steel pipe with black finish, provide nongalvanized ferrous metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

2.16 STEEL AND IRON FINISHES

A. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot dip process compliance with the following requirements:

1. ASTM A 153 for galvanizing iron and steel hardware.

2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick and heavier.

1.01.1.1.1.13 Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

3. Exteriors (SSPC Zone 1B): SSPC SP6 "Commercial Blast Cleaning."

4. Interiors (SSPC Zone 1A): SSPC SP3 "Power Tool Cleaning:

1.01.1.1.1.14 Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete, sprayed on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC PA1 "Paint Application Specification No. 1" for shop painting.

5. Stripe paint all edges, corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to the Project Site.

B. Center nosings on tread widths with noses flush with riser faces and tread surfaces.

C. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

D. Sequencing and Scheduling:

  1. Sequence and coordinate installation of wall handrails as follows:

    a. Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.

    b. Mount handrails only on gypsum board assemblies reinforced to receive anchors, and where the location of concealed anchor plates has been clearly marked for benefit of Installer.

1.01.1.1.1.14.1 INSTALLATION

E. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

F. All installation shall be in accordance with manufacturer’s published recommendations.

G. Fastening to In Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors as required.

H. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

I. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

J. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units which have been hot dip galvanized after fabrication, and are intended for bolted or screwed field connections.

K. Field Welding: Comply with AWS Code for procedures of manual shielded metal arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

  2. Obtain fusion without undercut or overlap.

  3. Remove welding flux immediately.

  4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.

1.01.1.1.1.15 Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint or zinc chromate primer.

3.2 FABRICATION

A. Provide miscellaneous metal work fabricated by processes and techniques which will result in the appropriate workmanship class as scheduled.

  1. Class 1 Workmanship: Sandblast exposed surfaces smooth with pits, mill marks, nicks, and scratches filled and ground smooth so that no defects are visible from a distance of 6' after painting.

   a. Conceal welds where possible. Where exposed, grind welds to small radius with uniform size cove. Welds shall be undetectable after painting.

   b. Use only flat head countersunk bolts in exposed locations.

   c. Fit all joints to hairline finish.

   d. Distortions visible to the eye will be cause for rejection.

2. Items required to have Class 1 Workmanship include:

   a. Stair railings, handrails, and guardrails in public and "high finish level" areas, interior and exterior.

   b. Steel framed stairs in public and "high finish level" areas, interior and exterior.

3. Class 2 Workmanship: Grind exposed surfaces to remove surface irregularities. Moderate imperfections not visible at 20 feet may remain. Mill marks may remain.

   a. Grind welds to small radius with uniform sized core and smooth transition between joined pieces.

   b. Use only flat or oval head, countersunk bolts where exposed to view.

   c. Straightness: Minor distortions will be permitted.

   d. Joints: Provide maximum gap of 1/16 inches.

4. Items required to have Class 2 Workmanship include:

   a. Stair railings, handrails, and guardrails in "back of house" areas, interior and exterior.

   b. Steel ladders.

   c. Steel framed stairs in "back of house" areas, interior and exterior.

   d. Steel bollards.

   e. Exposed door supports, guides, and bracing.

   f. Lavatory countertop supports.

   g. Garage overhead clearance bars.

5. Class 3 Workmanship: No improvement from mill finish required except preparation for priming and galvanizing.

6. Items required to have Class 3 Workmanship include all concealed items and those items exposed to view only in "service" areas such as mechanical equipment rooms, and other areas accessible only to building maintenance staff.

3.3 SETTING LOOSE PLATES

A. Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

B. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.

1. Use metallic nonshrink grout in concealed locations where not exposed to moisture; use nonmetallic nonshrink grout in exposed locations, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLATION OF STEEL PIPE RAILINGS AND HANDRAILS

A. Adjust railings prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction.

B. Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 1-1/2 inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated, or if not indicated, at spacing required to support structural loads. Secure wall brackets and wall return fittings to building construction as follows:

1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
2. Use type of bracket with pre drilled hole for exposed bolt anchorage.
3. For concrete and solid masonry anchorage, use drilled in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.
4. For hollow masonry anchorage, use toggle bolts having square heads.
5. For wood stud partitions, use lag bolts set into wood backing between studs. Coordinate with stud installations for accurate location of backing members.
6. For steel framed gypsum board assemblies, fasten brackets directly to steel framing or concealed anchors using self tapping screws of size and type required to support structural loads.

3.5 ADJUSTING AND CLEANING

A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC PA 1 requirements for touch up of field painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

1.01.1.1.1.16 For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 05 50 00 00

SECTION 05 52 13 00 – PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Component Design: Calculate structural properties of studs and joists in accordance with American Iron and Steel Institute (AISI) "Specification for Design of Cold Formed Steel Structural Members."

1.01.1.1.3 Welding: Use qualified welders and comply with American Welding Society (AWS) D1.3, "Structural Welding Code Sheet Steel."

B. Fire Rated Assemblies: Where framing units are components of assemblies indicated for a fire resistance rating, including those required for compliance with governing regulations, provide units that have been approved by governing authorities that have jurisdiction.

1.4 SUBMITTALS

A. Product Data:

1. Product data and installation instructions for each item of cold formed metal framing and accessories

B. Record Documents:

1. Shop drawings for special components and installations not fully dimensioned or detailed in manufacturer's product data.

    a. Include placing drawings for framing members showing size and gage designations, number, type, location, and spacing. Indicate supplemental strapping, bracing, splices, bridging, accessories, and details required for proper installation.

1.5 performance requirements

A. AISI "Specification": Calculate structural characteristics of cold-formed metal framing according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members" and the following:

1.01.1.1.4 AISI "Specification": Calculate structural characteristics of cold-formed metal framing according to AISI's "Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members" and the following:

1. Center for Cold-Formed Steel Structures (CCFSS) Technical Bulletin, Vol. 2, No. 1, February 1993 "AISI Specification Provisions for Screw Connections."

B. Structural Performance: Engineer, fabricate and erect cold-formed metal framing with the following minimum physical and structural properties:

1. Physical and Structural Properties: As indicated.

C. Structural Performance: Engineer, fabricate, and erect cold-formed metal framing to withstand design loads within limits and under conditions required.

1. Design framing systems to withstand design loads without deflections greater than the following:

    a. Exterior Load-Bearing Walls: Lateral deflection of 1/360 of the wall height, unless otherwise indicated.

    b. Interior Load-Bearing Walls: Lateral deflection of 1/360 of the wall height.

    c. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/240 of the wall height.

    d. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/360 of the wall height.

    e. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/600 of the wall height.

    f. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/720 of the wall height.

    g. Floor Joists: Vertical deflection of 1/240 of the span.

    h. Floor Joists: Vertical deflection of 1/360 of the span.

    i. Roof Trusses: Vertical deflection of 1/240 of the span.

    j. Roof Trusses: Vertical deflection of 1/360 of the span.

    1.01.1.1.4.1.1 Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects with subject to a maximum ambient temperature change (range) of 120 degrees F (67 degrees C).

2. Design framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings.

D. Design exterior nonload-bearing curtainwall framing to accommodate lateral deflection without regard to contribution of sheathing materials.

1.01.1.1.5 Engineering Responsibility: Engage a fabricator who assumes undivided responsibility for engineering cold formed metal framing by employing a qualified professional engineer to prepare design calculations, shop drawings, and other structural data.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 acceptable manufacturers

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include:

1. Alabama Metal Industries Corp.
2. American Studco, Inc.
3. Dale/Incor, Industries of Florida
4. Dale Industries, Inc.
5. Dietrich Industries, Inc.
6. Incor Plant Dale Industries
7. Marino/Ware; Div. of Ware Industries, Inc.
8. Super Stud Building Products, Inc.
9. Unimast, Inc.
10. United Construction Supply
11. United States Steel

1.01.1.1.5.1 METAL FRAMING

B. System Components: Manufacturers' standard load bearing steel studs and joists of type, size, shape, and gage as indicated. With each type of metal framing required, provide manufacturer's standard, steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories for applications indicated, as needed to provide a complete metal framing system.

1.01.1.1.6 Materials and Finishes:

1. For 16 gage and heavier units, fabricate metal framing components of structural quality steel sheet with a minimum yield point of 40,000 psi; ASTM A 446, A 570, or A 611.
2. For 18 gage and lighter units, fabricate metal framing components of commercial quality steel sheet with a minimum yield point of 33,000 psi; ASTM A 446, A 570, or A 611.
3. Provide galvanized finish to metal framing components complying with ASTM A 525 for minimum G 60 coating.
   a. Where metal framing provides back-up support for brick veneer, provide G90 (Z275) coating.

   1.01.1.1.6.1.1 Prime-Painted Steel Sheet: ASTM A 570 (ASTM A 570M) or ASTM A 611, cleaned, pretreated, and primed with manufacturer's baked-on, lead- and chromate-free, rust-inhibitive prime conforming to the performance requirements of FS TT-P-664.

   b. Finish of installation accessories to match that of main framing components, unless otherwise indicated.

   1.01.1.1.6.1.2 Fasteners: Provide nuts, bolts, washers, screws, and other fasteners with corrosion resistant plated finish.
4. Electrodes for Welding: Comply with AWS Code and as recommended by stud manufacturer.
5. Galvanizing Repair: Where galvanized surfaces are damaged, prepare surfaces and repair in accordance with procedures specified in ASTM A 780.

1.01.1.1.6.2 FRAMING ACCESSORIES

C. Fabricate steel-framing accessories of the same material and finish used for framing members, with minimum yield strength of 33,000 psi (230 MPa).

1.01.1.1.7 Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, including:

1. Supplementary framing
2. Bracing, bridging, and solid blocking
3. Web stiffeners
4. Gusset plates
5. Deflection track and vertical slide clips
6. Reinforcement plates

1.01.1.1.7.1 ANCHORS, CLIPS, AND FASTENERS

D. Steel Shapes and Clips: ASTM A 36 (ASTM A 36M), zinc coated by the hot-dip process according to ASTM A 123.

1.01.1.1.8 Cast-in-Place Anchor Bolts and Studs: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel hex-head bolts and studs; carbon-steel nuts; and flat, unhardened-steel washers. Zinc coated by hot-dip process according to ASTM A 153.

E. Welding Electrodes: Comply with AWS standards.

2.3 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

1.01.1.1.9 Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and a 30-minute working time.

2.4 FABRICATION

A. Framing components may be prefabricated into assemblies before erection. Fabricate panels plumb, square, true to line, and braced against racking with joints welded. Perform lifting of prefabricated units to prevent damage or distortion.

1.01.1.1.10 Fabricate units in jig templates to hold members in proper alignment and position and to assure consistent component placement.

B. Fastenings: Attach similar components by welding. Attach dissimilar components by welding, bolting, or screw fasteners, as standard with manufacturer.

1.01.1.1.11 Wire tying of framing components is not permitted.

C. Fabrication Tolerances: Fabricate units to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet.

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 PREPARATION

A. Pre-Installation Conference:

1. Prior to start of installation of metal framing systems, meet at Project Site with installers of other work including door and window frames and mechanical and electrical work.

2. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.

1.01.1.1.11.1 INSTALLATION

B. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.12 All installation shall be in accordance with manufacturer’s published recommendations.

C. Install metal framing systems in accordance with manufacturer's printed or written instructions and recommendations.

1.01.1.1.13 Runner Tracks: Install continuous tracks sized to match studs. Align tracks accurately to layout at base and tops of studs. Secure tracks as recommended by stud manufacturer for type of construction involved, except do not exceed 24 inches on center spacing for nail or powder driven fasteners or 16 inches on center for other types of attachment. Provide fasteners at corners and ends of tracks.

D. Installation of Wall Studs: Secure studs to top and bottom runner tracks by either welding or screw fastening at both inside and outside flanges.

1.01.1.1.14 Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

E. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.

1.01.1.1.15 Install supplementary framing, blocking, and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations and industry standards in each case, considering weight or loading resulting from item supported.

F. Frame wall openings larger than two feet square with double stud at each jamb of frame except where more than two are either shown or indicated in manufacturer's instructions. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full height studs of wall. Secure stud system wall opening frame in manner indicated.

1.01.1.1.16 Frame both sides of expansion and control joints with separate studs; do not bridge the joint with components of stud system.

G. Install horizontal stiffeners in stud system, spaced (vertical distance) at not more than 54 inches on center. Weld at each intersection.

1.01.1.1.17 Erection Tolerances: Bolt or weld wall panels (at both horizontal and vertical junctures) to produce flush, even, true to line joints.

1. Maximum variation in plane and true position between prefabricated assemblies should not exceed 1/16 inch.

H. Installation of Joists: Install level, straight, and plumb, complete with bracing and reinforcing as indicated on drawings. Provide not less than 1-1/2 inch end bearing.

1.01.1.1.18 Reinforce ends with end clips, steel hangers, steel angle clips, steel stud section, or as otherwise recommended by joist manufacturer.

I. Where required, reinforce joists at interior supports with single short length of joist section located directly over interior support, snap on shoe, 30 percent side piece lapped reinforcement, or other method recommended by joist manufacturer.

1.01.1.1.19 Secure joists to interior support systems to prevent lateral movement of bottom flange.

J. Field Painting: Touch up damaged shop applied protective coatings. Use compatible primer for prime coated surfaces; use galvanizing repair system for galvanized surfaces.

END OF SECTION 05 40 00 00

SECTION 05 53 00 00 – METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Component Design: Calculate structural properties of studs and joists in accordance with American Iron and Steel Institute (AISI) "Specification for Design of Cold Formed Steel Structural Members."

1.01.1.1.3 Welding: Use qualified welders and comply with American Welding Society (AWS) D1.3, "Structural Welding Code Sheet Steel."

B. Fire Rated Assemblies: Where framing units are components of assemblies indicated for a fire resistance rating, including those required for compliance with governing regulations, provide units that have been approved by governing authorities that have jurisdiction.

1.4 SUBMITTALS

A. Product Data:

1. Product data and installation instructions for each item of cold formed metal framing and accessories

B. Record Documents:

1. Shop drawings for special components and installations not fully dimensioned or detailed in manufacturer's product data.

    a. Include placing drawings for framing members showing size and gage designations, number, type, location, and spacing. Indicate supplemental strapping, bracing, splices, bridging, accessories, and details required for proper installation.

1.5 performance requirements

A. AISI "Specification": Calculate structural characteristics of cold-formed metal framing according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members" and the following:

1.01.1.1.4 AISI "Specification": Calculate structural characteristics of cold-formed metal framing according to AISI's "Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members" and the following:

1. Center for Cold-Formed Steel Structures (CCFSS) Technical Bulletin, Vol. 2, No. 1, February 1993 "AISI Specification Provisions for Screw Connections."

B. Structural Performance: Engineer, fabricate and erect cold-formed metal framing with the following minimum physical and structural properties:

1. Physical and Structural Properties: As indicated.

C. Structural Performance: Engineer, fabricate, and erect cold-formed metal framing to withstand design loads within limits and under conditions required.

1. Design framing systems to withstand design loads without deflections greater than the following:

a. Exterior Load-Bearing Walls: Lateral deflection of 1/360 of the wall height, unless otherwise indicated.

b. Interior Load-Bearing Walls: Lateral deflection of 1/360 of the wall height.

c. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/240 of the wall height.

d. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/360 of the wall height.

e. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/600 of the wall height.

f. Exterior Nonload-Bearing Curtainwall: Lateral deflection of 1/720 of the wall height.

g. Floor Joists: Vertical deflection of 1/240 of the span.

h. Floor Joists: Vertical deflection of 1/360 of the span.

i. Roof Trusses: Vertical deflection of 1/240 of the span.

j. Roof Trusses: Vertical deflection of 1/360 of the span.

1.01.1.1.4.1.1 Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects with subject to a maximum ambient temperature change (range) of 120 degrees F (67 degrees C).

2. Design framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings.

D. Design exterior nonload-bearing curtainwall framing to accommodate lateral deflection without regard to contribution of sheathing materials.

1.01.1.1.5 Engineering Responsibility: Engage a fabricator who assumes undivided responsibility for engineering cold formed metal framing by employing a qualified professional engineer to prepare design calculations, shop drawings, and other structural data.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 acceptable manufacturers

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include:

1. Alabama Metal Industries Corp.
2. American Studco, Inc.
3. Dale/Incor, Industries of Florida
4. Dale Industries, Inc.
5. Dietrich Industries, Inc.
6. Incor Plant Dale Industries
7. Marino/Ware; Div. of Ware Industries, Inc.
8. Super Stud Building Products, Inc.
9. Unimast, Inc.
10. United Construction Supply
11. United States Steel

1.01.1.1.5.1 METAL FRAMING

B. System Components: Manufacturers' standard load bearing steel studs and joists of type, size, shape, and gage as indicated. With each type of metal framing required, provide manufacturer's standard, steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories for applications indicated, as needed to provide a complete metal framing system.

1.01.1.1.6 Materials and Finishes:

1. For 16 gage and heavier units, fabricate metal framing components of structural quality steel sheet with a minimum yield point of 40,000 psi; ASTM A 446, A 570, or A 611.

2. For 18 gage and lighter units, fabricate metal framing components of commercial quality steel sheet with a minimum yield point of 33,000 psi; ASTM A 446, A 570, or A 611.

3. Provide galvanized finish to metal framing components complying with ASTM A 525 for minimum G 60 coating.

    a. Where metal framing provides back-up support for brick veneer, provide G90 (Z275) coating.

    1.01.1.1.6.1.1 Prime-Painted Steel Sheet: ASTM A 570 (ASTM A 570M) or ASTM A 611, cleaned, pretreated, and primed with manufacturer's baked-on, lead- and chromate-free, rust-inhibitive prime conforming to the performance requirements of FS TT-P-664.

    b. Finish of installation accessories to match that of main framing components, unless otherwise indicated.

    1.01.1.1.6.1.2 Fasteners: Provide nuts, bolts, washers, screws, and other fasteners with corrosion resistant plated finish.

4. Electrodes for Welding: Comply with AWS Code and as recommended by stud manufacturer.

5. Galvanizing Repair: Where galvanized surfaces are damaged, prepare surfaces and repair in accordance with procedures specified in ASTM A 780.

1.01.1.1.6.2 FRAMING ACCESSORIES

C. Fabricate steel-framing accessories of the same material and finish used for framing members, with minimum yield strength of 33,000 psi (230 MPa).

1.01.1.1.7 Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, including:

1. Supplementary framing
2. Bracing, bridging, and solid blocking
3. Web stiffeners
4. Gusset plates
5. Deflection track and vertical slide clips
6. Reinforcement plates

1.01.1.1.7.1 ANCHORS, CLIPS, AND FASTENERS

D. Steel Shapes and Clips: ASTM A 36 (ASTM A 36M), zinc coated by the hot-dip process according to ASTM A 123.

1.01.1.1.8 Cast-in-Place Anchor Bolts and Studs: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel hex-head bolts and studs; carbon-steel nuts; and flat, unhardened-steel washers. Zinc coated by hot-dip process according to ASTM A 153.

E. Welding Electrodes: Comply with AWS standards.

2.3 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

1.01.1.1.9 Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and a 30-minute working time.

2.4 FABRICATION

A. Framing components may be prefabricated into assemblies before erection. Fabricate panels plumb, square, true to line, and braced against racking with joints welded. Perform lifting of prefabricated units to prevent damage or distortion.

1.01.1.1.10 Fabricate units in jig templates to hold members in proper alignment and position and to assure consistent component placement.

B. Fastenings: Attach similar components by welding. Attach dissimilar components by welding, bolting, or screw fasteners, as standard with manufacturer.

1.01.1.1.11 Wire tying of framing components is not permitted.

C. Fabrication Tolerances: Fabricate units to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet.

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 PREPARATION

A. Pre-Installation Conference:

1. Prior to start of installation of metal framing systems, meet at Project Site with installers of other work including door and window frames and mechanical and electrical work.

2. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.

1.01.1.1.11.1 INSTALLATION

B. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.12 All installation shall be in accordance with manufacturer’s published recommendations.

C. Install metal framing systems in accordance with manufacturer's printed or written instructions and recommendations.

1.01.1.1.13 Runner Tracks: Install continuous tracks sized to match studs. Align tracks accurately to layout at base and tops of studs. Secure tracks as recommended by stud manufacturer for type of construction involved, except do not exceed 24 inches on center spacing for nail or powder driven fasteners or 16 inches on center for other types of attachment. Provide fasteners at corners and ends of tracks.

D. Installation of Wall Studs: Secure studs to top and bottom runner tracks by either welding or screw fastening at both inside and outside flanges.

1.01.1.1.14 Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

E. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.

1.01.1.1.15 Install supplementary framing, blocking, and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations and industry standards in each case, considering weight or loading resulting from item supported.

F. Frame wall openings larger than two feet square with double stud at each jamb of frame except where more than two are either shown or indicated in manufacturer's instructions. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full height studs of wall. Secure stud system wall opening frame in manner indicated.

1.01.1.1.16 Frame both sides of expansion and control joints with separate studs; do not bridge the joint with components of stud system.

G. Install horizontal stiffeners in stud system, spaced (vertical distance) at not more than 54 inches on center. Weld at each intersection.

1.01.1.1.17 Erection Tolerances: Bolt or weld wall panels (at both horizontal and vertical junctures) to produce flush, even, true to line joints.

1. Maximum variation in plane and true position between prefabricated assemblies should not exceed 1/16 inch.

H. Installation of Joists: Install level, straight, and plumb, complete with bracing and reinforcing as indicated on drawings. Provide not less than 1-1/2 inch end bearing.

1.01.1.1.18 Reinforce ends with end clips, steel hangers, steel angle clips, steel stud section, or as otherwise recommended by joist manufacturer.

I. Where required, reinforce joists at interior supports with single short length of joist section located directly over interior support, snap on shoe, 30 percent side piece lapped reinforcement, or other method recommended by joist manufacturer.

1.01.1.1.19 Secure joists to interior support systems to prevent lateral movement of bottom flange.

J. Field Painting: Touch up damaged shop applied protective coatings. Use compatible primer for prime coated surfaces; use galvanizing repair system for galvanized surfaces.

END OF SECTION 05 53 00 00

SECTION 05 70 00 00 – DECORATIVE METAL

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for ornamental metal. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Decorative window security bars.
      b. Decorative mechanical grilles and frames.
      c. Decorative-metal-clad, hollow-metal doors and frames.
      d. Custom door pulls.
      e. Combination hall push-button stations.
      f. Metal reveals at wood paneling.
      g. Cast-metal rosettes at marble joints.

C. Submittals
   1. Product Data: For each type of product indicated, including finishing materials.
   2. LEED Submittals:
      a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   3. Shop Drawings: Show fabrication and installation details for decorative metal.
      a. Include plans, elevations, component details, and attachments to other work.
      b. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
   4. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.
   5. Samples: For each type of exposed finish required.
      a. Sections of linear shapes.
      b. Full-size Samples of castings and forgings.
         1) For custom castings, submit finished Samples showing ability to reproduce detail, cast-metal color, and quality of finish. Samples may be of similar previous work.
      c. Samples of welded and brazed joints showing quality of workmanship and color matching of materials.
   6. Qualification Data: For qualified fabricator **OR** organic-coating applicator **OR** anodic finisher **OR** powder-coating applicator, **as directed**.
   7. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.
   8. Welding certificates.

D. Quality Assurance
   1. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
   2. Installer Qualifications: Fabricator of products.
   3. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

4. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
5. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
6. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
   d. AWS D1.6, "Structural Welding Code - Stainless Steel."
7. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling

1. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
2. Deliver and store cast-metal products in wooden crates surrounded by sufficient packing material to ensure that products will not be cracked or otherwise damaged.

F. Project Conditions

1. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

G. Coordination

1. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.2 PRODUCTS

A. Metals, General

1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Aluminum

1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
   a. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
   b. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
   c. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M) or ASTM B 483/B 483M, Alloy 6063-T832.
   d. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003-H14 **OR** Alloy 5005-H32 **OR** Alloy 6061-T6, **as directed**.
   e. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
   f. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

C. Copper Alloys

1. Copper and Copper Alloys, General: Provide alloys indicated and temper to suit application and forming methods but with strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.

2. Extruded Shapes, Bronze: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
3. Extruded Shapes, Brass: ASTM B 249/B 249M, Alloy UNS No. C36000 (free-cutting brass).
4. Extruded Shapes, Nickel Silver: ASTM B 249/B 249M, Alloy UNS No. C79600.
5. Seamless Pipe, Bronze: ASTM B 43, Alloy UNS No. C23000 (red brass, 85 percent copper).
6. Seamless Tube, Bronze: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
7. Seamless Tube, Brass: ASTM B 135 (ASTM B 135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
8. Seamless Tube, Copper: ASTM B 75 (ASTM B 75M), Alloy UNS No. C12200 (phosphorous deoxidized, high residual phosphorous copper).
9. Castings, Bronze: ASTM B 62, Alloy UNS No. C83600 (85-5-5-5 or No. 1 composition commercial red brass) or ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
10. Castings, Brass: ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
11. Castings, Copper: ASTM B 824, with a minimum of 99.9 percent copper.
12. Castings, Nickel Silver: ASTM B 584, Alloy UNS No. C97300 (12 percent leaded nickel silver).
13. Plate, Sheet, Strip, and Bars; Bronze: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
14. Plate, Sheet, Strip, and Bars; Brass: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
15. Plate, Sheet, Strip, and Bars; Copper: ASTM B 152/B 152M, Alloy UNS No. C11000 (electrolytic tough pitch copper) or UNS No. C12200 (phosphorous deoxidized, high-residual phosphorous copper).

D. Stainless Steel
   1. Tubing: ASTM A 554, Grade MT 304 **OR** Grade MT 316 **OR** Grade MT 316L, **as directed**.
   2. Pipe: ASTM A 312/A 312M, Grade TP 304 **OR** Grade TP 316 **OR** Grade TP 316L, **as directed**.
   3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 **OR** Grade CF 8M or CF 3M, **as directed**.
   4. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
   5. Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
   6. Wire Rope and Fittings:
      a. Wire Rope: 1-by-19 **OR** 7-by-7 **OR** 7-by-19, **as directed**, wire rope made from wire complying with ASTM A 492, Type 316.
      b. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

E. Steel And Iron
   1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
   2. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
   3. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
   4. Plates, Shapes, and Bars: ASTM A 36/A 36M.
   5. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M unless otherwise indicated.
   6. Steel Sheet, Cold Rolled: ASTM A 1008/A 1008M, either commercial steel or structural steel, exposed.

F. Titanium
   1. Titanium Strip, Sheet, and Plate: ASTM B 265, Grade 1.
   2. Titanium Bars: ASTM B 348, Grade 1.

G. Fasteners
   1. Fastener Materials: Unless otherwise indicated, provide the following:

  - a. Aluminum Items: Aluminum **OR** Type 304 stainless-steel **OR** Type 316 stainless-steel, **as directed**, fasteners.
  - b. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, muntz metal (Alloy 280) fasteners where exposed.
  - c. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, brass (Alloy 260 or 360) fasteners where exposed.
  - d. Stainless-Steel Items: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
  - e. Titanium Items: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
  - f. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless-steel fasteners where exposed.
  - g. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
  - h. Dissimilar Metals: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
- 2. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
- 3. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated **OR** exposed fasteners are unavoidable, **as directed**.
  - a. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
- 4. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- 5. Post-Installed Anchors: Torque-controlled expansion type or chemical type.
  - a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
  - b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

H. Miscellaneous Materials
- 1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
  - a. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- 2. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.
- 3. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- 4. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- 5. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.
- 6. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings", **as directed**.
- 7. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- 8. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- 9. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
- 10. Intermediate Coats and Topcoats for Steel: Provide products that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.

11. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.
12. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.
13. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

I. Fabrication, General

1. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
2. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
3. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
4. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
5. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
6. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
7. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
8. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
9. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
10. Comply with AWS for recommended practices in shop welding and brazing. Weld and braze behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
    a. Where welding and brazing cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint **OR** Type 2 Welds: completely sanded joint, some undercutting and pinholes okay **OR** Type 3 Welds: partially dressed weld with spatter removed **OR** Type 4 Welds: good quality, uniform undressed weld with minimal splatter, **as directed**.
11. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

J. Decorative Window Security Bars

1. General: Fabricate decorative window grilles to designs indicated from steel bars and shapes of sizes and profiles indicated. Form steel bars by bending, forging, coping, mitering, and welding.
2. Welding: Interconnect grille members with full-length, full-penetration welds unless otherwise indicated. Use welding method that is appropriate for metal and finish indicated and that develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.
3. Brackets, Fittings, and Anchors: Provide wall brackets, fittings, and anchors to connect decorative window grilles to other work unless otherwise indicated.
    a. Furnish inserts and other anchorage devices to connect decorative window grilles to concrete and masonry work. Coordinate anchorage devices with supporting structure.
    b. Fabricate anchorage devices that are capable of withstanding loads indicated.

K. Decorative Mechanical Grilles

1. Fabricate decorative grilles from perforated aluminum **OR** brass **OR** bronze **OR** stainless-steel **OR** steel, **as directed**, sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.
   a. Form perforations to match existing grilles.
      OR
      Drawings indicate perforated metal patterns required and are based on products of one manufacturer. Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by UT Health.
2. Drill and countersink grilles for mounting screws at 2 inches (50 mm) from corners and at 10 inches (250 mm) or less o.c. Provide units with oval-head wood **OR** self-tapping machine, **as directed**, screws.
3. Fabricate grille frames from extruded aluminum **OR** brass **OR** bronze, **as directed**, of profiles, and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates welded **OR** brazed, **as directed**, to back of frames.
   a. Secure grilles in frames with 0.5-inch- (12-mm-) long welds **OR** brazing, **as directed**, along perimeter of grilles at 4 inches (100 mm) o.c.
   b. Provide frame profiles to match existing frames.
      OR
      Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by UT Health.
4. Drill and countersink frames for mounting screws at 4 inches (100 mm) from corners and at 16 inches (400 mm) or less o.c. Provide units with oval-head wood **OR** self-tapping machine, **as directed**, screws.

L. Decorative-Metal-Clad Doors And Frames

1. Laminate 0.0403-inch- (1.0-mm-) thick, muntz-metal **OR** 0.0403-inch- (1.0-mm-) thick, brass **OR** 0.0375-inch- (0.95-mm-) thick, stainless-steel **OR** 0.024-inch- (0.6-mm-) thick, titanium, **as directed**, sheets to outside face of hollow-metal doors and frames at locations and to comply with details indicated. Use adhesive recommended by metal fabricator that will fully bond metal to metal and that will prevent telegraphing and oil canning.
   a. Hollow-metal doors and frames are specified in Division 8 Section "Steel Doors and Frames."

M. Custom Door Pulls

1. Fabricate custom door pulls from brass **OR** bronze **OR** stainless-steel, **as directed**, bar stock of profile indicated, fabricated to shapes indicated. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile. Drill and tap door pulls to receive through bolts for attachment to doors.
2. Fabricate backing plates for custom door pulls from 1/8-inch (3.2-mm) brass **OR** bronze **OR** stainless-steel, **as directed**, sheet. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal. Drill and countersink holes where indicated for screws and bolts.
3. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.

N. Combination Hall Push-Button Stations

1. Fabricate units of brass **OR** bronze **OR** stainless steel, **as directed**, to comply with details indicated. Coordinate with requirements in Division 14 Section "Electric Traction Elevators" to provide integrated, closely fitted assemblies.
   a. Fabricate faceplates from 1/8-inch- (3.2-mm-) thick sheet with edges beveled at a 45-degree angle for one-half thickness of metal.

b. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal 4-inch (100-mm) wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are 10 by 10 by 3-1/2 inches (250 by 250 by 90 mm) in depth.

c. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of 1/16 inch (1.6 mm) with engraving painted red. Make signs 5 inches (125 mm) wide by 8 inches (200 mm) high.

d. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station, card reader, **as directed**, and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.

O. Metal Reveals

1. Fabricate metal reveals for wood paneling from 3/4-by-3/4-by-1/16-inch (19-by-19-by-3-mm) extruded-bronze **OR** 3/4-by-3/4-by-0.025-inch (19-by-19-by-0.6-mm) brake-formed, stainless-steel **OR** 3/4-by-3/4-by-0.015-inch (19-by-19-by-0.4-mm) brake-formed titanium, **as directed**, channels. Drill for mounting screws 6 inches (150 mm) from ends of channels and not more than 24 inches (600 mm) o.c. Locate mounting screws at same heights for all channels. Provide black-finished, **as directed**, hex-socket, wafer-head screws for mounting reveals.

P. Cast-Metal Rosettes

1. Fabricate cast-metal rosettes to design indicated from aluminum **OR** brass **OR** bronze **OR** nickel silver, **as directed**. Drill and tap castings for threaded mounting studs.
   a. Provide custom castings to match design indicated.
   b. Manufacturer's stock castings may be considered, provided deviations are minor and do not change design concept as judged solely by UT Health.
   c. Drawings indicate cast-metal rosette designs required and are based on products of one manufacturer. Castings produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by UT Health.

Q. Finishes, General

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

R. Aluminum Finishes

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

S. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching UT Health's sample.
11. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate), with color matching UT Health's sample.
12. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air drying, as specified below), with color matching UT Health's sample:

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
13. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air drying; Mechanical Finish: buffed, as specified; Coating: clear, organic, air drying, as specified below), with blackening and buffing matching UT Health's sample:
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

T. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    a. Run grain of directional finishes with long dimension of each piece.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
4. Directional Satin Finish: No. 4.
5. Dull Satin Finish: No. 6.
6. Reflective, Directional Polish: No. 7.
7. Mirrorlike Reflective, Nondirectional Polish: No. 8.
8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
9. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.
10. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.
    a. Product: Subject to compliance with requirements, provide INCO colored stainless-steel finish as developed and licensed by International Nickel Co., Ltd.
    b. Color: Match UT Health's sample **OR** As selected from finisher's full range, **as directed**.

U. Steel And Iron Finishes
1. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123/A 123M.
    a. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A 153/A 153M.
    b. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
    c. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
2. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
3. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning" **OR** requirements indicated below, **as directed**:
    a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    b. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
    a. Shop prime uncoated ferrous-metal surfaces with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
    b. Do not apply primer to galvanized surfaces.
5. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.

a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

6. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
   a. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
   c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
   d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. Powder-Coat Finish: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
   a. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
   b. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
   c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
   d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

V. Titanium Finishes
1. General: Fabricate items from finished titanium stock, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.
2. Dull Matte Finish: Pickled and annealed.
3. Bright Matte Finish: Vacuum annealed.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation, General
1. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.
2. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
3. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.
4. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

5. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.
6. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
    a. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.
7. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
8. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.
9. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Installing Decorative Window Security Bars
1. Fasten security bar frames to concrete and masonry walls with cast-in-place or postinstalled anchors. Peen exposed threads of anchors to prevent removal of security bars.

D. Installing Decorative Mechanical Grilles
1. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.
    a. Secure to framing and blocking with specified fasteners.
    b. On marble, brick, and other solid surfaces, secure with wood screws in lead plugs.

E. Installing Decorative-Metal-Clad, Hollow-Metal Doors And Frames
1. Install doors and frames to comply with requirements specified in Division 08 Section "Hollow Metal Doors And Frames".

F. Installing Custom Door Pulls
1. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head wood **OR** self-tapping metal, **as directed**, screws and secure pulls through doors and backing plates with oval-head machine screws.

G. Installing Combination Hall Push-Button Stations
1. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components specified in Division 14 Section "Electric Traction Elevators". Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.

H. Installing Metal Reveals At Wood Paneling
1. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.

I. Installing Cast-Metal Rosettes At Marble Joints
1. Install cast-metal rosettes at intersections of marble joints where indicated. Install only after marble work is complete and joints are grouted. Secure to wall by drilling a 3/4-inch- (19-mm-) round hole at intersection of marble joints and by filling hole with molding plaster into which threaded stud is embedded. Angle drill and rotate so bottom of hole is larger than at surface.
    a. Secure rosettes in place with masking tape until plaster sets. After plaster has set, remove masking tape and adhesive residue.

J. Cleaning And Protection
1. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

   OR

   Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
5. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.
6. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 70 00 00

SECTION 05800 – EXPANSION CONTROL

PART 1 - GENERAL

1.1 SCOPE OF STANDARD

A. This standard provides general guidance concerning the specific preferences of the UT Health for manufactured expansion joint assemblies, including frames, covers, and gaskets.

B. UT Health recognizes that project conditions and requirements vary, thus precluding absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT Health projects.

1.2 REFERENCE STANDARDS

A. Expansion joints: Refer to Section 07940 JOINTING OF EXTERIOR VERTICAL SURFACES for expansion control recommendations at exterior vertical concrete and masonry joints.

B. Waterproofing expansion joints in horizontal surfaces of plazas and decks: Refer to 07050 Plazas and Decks.

1.3 QUALITY CONTROL

A. A proper selection of design and materials for each individual condition will accommodate the anticipated movement of the building.

B. Considerations for a proper selection include determining the joint size. This must be determined by the project designing structural engineer. Also, the fire rating of the joint needs proper consideration and selection, and the exposure condition will govern the need for waterproofing details.

1.4 GENERAL REQUIREMENTS

A. Expansion joint cover: The specific condition will determine the applicable selection. Coordinate the choice with the UT Health project Design representative. In remodeling projects, all expansion controls already installed must be retained, or replaced if necessary.

B. Waterproofing expansion joints in horizontal surfaces of plazas and decks: Avoid driving or dragging heavy equipment or materials over in-place expansion joint assemblies.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF STANDARD 05800

SECTION 06 10 00 00 – ROUGH CARPENTRY

1.1 GENERAL

A. Description Of Work:
   1. This specification covers the furnishing and installation of materials for rough carpentry. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following:
      a. Framing with dimension lumber.
      b. Framing with timber.
      c. Framing with engineered wood products.
      d. Rooftop equipment bases and support curbs.
      e. Wood blocking, cants, and nailers.
      f. Wood furring and grounds.
      g. Wood sleepers.
      h. Utility shelving.
      i. Plywood backing panels.

C. Definitions
   1. Exposed Framing: Framing not concealed by other construction.
   2. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
   3. Timber: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
   4. Lumber grading agencies, and the abbreviations used to reference them, include the following:
      a. NeLMA: Northeastern Lumber Manufacturers' Association.
      b. NLGA: National Lumber Grades Authority.
      c. RIS: Redwood Inspection Service.
      d. SPIB: The Southern Pine Inspection Bureau.
      e. WCLIB: West Coast Lumber Inspection Bureau.
      f. WWPA: Western Wood Products Association.

D. Submittals
   1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
      a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
      b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
      c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
      d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
      e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
   2. LEED Submittals:
      a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.

   b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
   c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
3. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
4. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
   a. Wood-preservative-treated wood.
   b. Fire-retardant-treated wood.
   c. Engineered wood products.
   d. Power-driven fasteners.
   e. Powder-actuated fasteners.
   f. Expansion anchors.
   g. Metal framing anchors.

E. Quality Assurance
1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
   a. Dimension lumber framing.
   b. Timber.
   c. Laminated-veneer lumber.
   d. Parallel-strand lumber.
   e. Prefabricated wood I-joists.
   f. Rim boards.
   g. Miscellaneous lumber.

F. Delivery, Storage, And Handling
1. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

1.2 PRODUCTS

A. Wood Products, General
1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   a. Factory mark each piece of lumber with grade stamp of grading agency.
   b. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
   c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   d. Provide dressed lumber, S4S, unless otherwise indicated.
2. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

a. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. Wood-Preservative-Treated Lumber
  1. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
    a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
    b. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
  2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
  3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
    a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
  4. Application: Treat all rough carpentry, unless otherwise indicated, **OR** items indicated on Drawings, and the following, **as directed**:
    a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
    b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
    c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
    d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
    e. Wood floor plates that are installed over concrete slabs-on-grade.

C. Fire-Retardant-Treated Materials
  1. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
    a. Use Exterior type for exterior locations and where indicated.
    b. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
    c. Use Interior Type A, unless otherwise indicated.
  2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
    a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
  3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
  4. Application: Treat all rough carpentry, unless otherwise indicated, **OR** items indicated on Drawings, and the following, **as directed**:
    a. Framing for raised platforms.
    b. Concealed blocking.
    c. Framing for non-load-bearing partitions.
    d. Framing for non-load-bearing exterior walls.
    e. Roof construction.
    f. Plywood backing panels.

D. Dimension Lumber Framing

1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness **OR** 19 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Non-Load-Bearing Interior Partitions: Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
3. Exterior and Load-Bearing Walls **OR** Framing Other Than Non-Load-Bearing Interior Partitions **OR** Framing Other Than Interior Partitions, **as directed**: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
4. Ceiling Joists (Non-Load-Bearing): Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
5. Joists, Rafters, and Other Framing Not Listed Above: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
6. Exposed Exterior **OR** Interior, **as directed**, Framing Indicated to Receive a Stained or Natural Finish: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
    a. Species and Grade: As indicated above for load-bearing construction of same type.
    b. Species and Grade: Hem-fir (north), Select Structural **OR** No. 1, **as directed**, grade; NLGA.
    c. Species and Grade: Southern pine, Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade; SPIB.
    d. Species and Grade: Douglas fir-larch; Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
    e. Species and Grade: Mixed southern pine, Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade; SPIB.
    f. Species and Grade: Spruce-pine-fir, Select Structural **OR** No. 1, **as directed**, grade; NLGA.
    g. Species and Grade: Douglas fir-south; Select Structural **OR** No. 1, **as directed**, grade; WWPA.
    h. Species and Grade: Hem-fir; Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
    i. Species and Grade: Douglas fir-larch (north); Select Structural **OR** No. 1, **as directed**, grade; NLGA.
    j. Species and Grade: Spruce-pine-fir (south), Select Structural **OR** No. 1, **as directed**, grade; NeLMA, WCLIB, or WWPA.
    k. Species and Grade: Eastern hemlock-balsam fir or eastern hemlock-tamarack; Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    l. Species and Grade: Beech-birch-hickory, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    m. Species and Grade: Northern red oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    n. Species and Grade: Redwood, Clear Heart Structural **OR** Clear Structural **OR** Select Structural **OR** No. 1, **as directed**, grade; RIS.
    o. Species and Grade: Mixed oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    p. Species and Grade: Mixed maple, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    q. Species and Grade: Western cedars, Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.

E. Timber Framing
  1. Provide timber framing complying with the following requirements, according to grading rules of grading agency indicated:
    a. Species and Grade: Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south; Select Structural **OR** No. 1, **as directed**, grade; NLGA, WCLIB, or WWPA.
    b. Species and Grade: Eastern hemlock, eastern hemlock-tamarack, or eastern hemlock-tamarack (north); Select Structural **OR** No. 1, **as directed**, grade; NeLMA or NLGA.
    c. Species and Grade: Hem-fir or hem-fir (north), Select Structural **OR** No. 1, **as directed**, grade; NLGA, WCLIB, or WWPA.
    d. Species and Grade: Mixed maple, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    e. Species and Grade: Mixed oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    f. Species and Grade: Southern pine, Select Structural **OR** No. 1, **as directed**, grade; SPIB.
    g. Maximum Moisture Content: 20 **OR** 23, **as directed**, percent.
    h. Additional Restriction: Free of heart centers.

F. Engineered Wood Products
  1. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
    a. Extreme Fiber Stress in Bending, Edgewise: 3100 psi (21.3 MPa) **OR** 2900 psi (20.0 MPa) **OR** 2600 psi (17.9 MPa) **OR** 2250 psi (15.5 MPa), **as directed**, for 12-inch nominal- (286-mm actual-) depth members.
    b. Modulus of Elasticity, Edgewise: 2,000,000 psi (13 700 MPa) **OR** 1,800,000 psi (12 400 MPa) **OR** 1,500,000 psi (10 300 MPa), **as directed**.
  2. Parallel-Strand Lumber: Structural composite lumber made from wood strand elements with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
    a. Extreme Fiber Stress in Bending, Edgewise: 2900 psi (20 MPa) for 12-inch nominal- (286-mm actual-) depth members.
    b. Modulus of Elasticity, Edgewise: 2,200,000 psi (15 100 MPa).
  3. Wood I-Joists: Prefabricated units, I-shaped in cross section, made with solid or structural composite lumber flanges and wood-based structural panel webs, let into and bonded to flanges. Provide units complying with material requirements of and with structural capacities established and monitored according to ASTM D 5055.
    a. Provide I-joists manufactured without urea formaldehyde.
    b. Web Material: Either oriented strand board or plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1 **OR** Plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1 **OR** Plywood, complying with DOC PS 1, Exterior grade, **as directed**.
    c. Structural Properties: Provide units with depths and design values not less than those indicated.
    d. Provide units complying with APA PRI-400, factory marked with APA trademark indicating nominal joist depth, joist class, span ratings, mill identification, and compliance with APA standard.
  4. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research/evaluation report for I-joists.
    a. Manufacturer: Provide products by same manufacturer as I-joists.
    b. Material: All-veneer product **OR** glued-laminated wood **OR** product made from any combination solid lumber, wood strands, and veneers, **as directed**. Provide rim boards made without urea formaldehyde.
    c. Thickness: 1 inch (25 mm) **OR** 1-1/8 inches (28 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
    d. Provide performance-rated product complying with APA PRR-401, rim board **OR** rim board plus, **as directed**, grade, factory marked with APA trademark indicating thickness, grade, and compliance with APA standard.

G. Miscellaneous Lumber

1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   a. Blocking.
   b. Nailers.
   c. Rooftop equipment bases and support curbs.
   d. Cants.
   e. Furring.
   f. Grounds.
   g. Utility shelving.
2. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed,** grade lumber with 15 **OR** 19, **as directed,** percent maximum moisture content of any species.
3. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species:
   a. Hem-fir (north); NLGA.
   b. Mixed southern pine; SPIB.
   c. Spruce-pine-fir; NLGA.
   d. Hem-fir; WCLIB, or WWPA.
   e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
   f. Western woods; WCLIB or WWPA.
   g. Northern species; NLGA.
   h. Eastern softwoods; NeLMA.
4. For exposed boards, provide lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species and grades:
   a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or 2 Common (Sterling) **OR** Standard or No. 3 Common, **as directed,** grade; NeLMA, NLGA, WCLIB, or WWPA.
   b. Mixed southern pine, No. 1 **OR** 2, **as directed,** grade; SPIB.
   c. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
   d. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
5. For concealed boards, provide lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species and grades:
   a. Mixed southern pine, No. 2 **OR** 3, **as directed,** grade; SPIB.
   b. Hem-fir or hem-fir (north), Construction or 2 Common **OR** Standard or 3 Common, **as directed,** grade; NLGA, WCLIB, or WWPA.
   c. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common **OR** Standard or 3 Common, **as directed,** grade; NeLMA, NLGA, WCLIB, or WWPA.
   d. Eastern softwoods, No. 2 **OR** 3, **as directed,** Common grade; NeLMA.
   e. Northern species, No. 2 **OR** 3, **as directed,** Common grade; NLGA.
   f. Western woods, Construction or No. 2 Common **OR** Standard or No. 3 Common, **as directed,** grade; WCLIB or WWPA.
6. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
7. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
8. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

H. Plywood Backing Panels

1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated**, as directed**, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

I. Fasteners
   1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
      a. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
   2. Nails, Brads, and Staples: ASTM F 1667.
   3. Power-Driven Fasteners: NES NER-272.
   4. Wood Screws: ASME B18.6.1.
   5. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
   6. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
   7. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
      a. Material:
         1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
            OR
            Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

J. Metal Framing Anchors
   1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
   2. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
      a. Use for interior locations where stainless steel is not indicated.
   3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
      a. Use for exterior locations and where indicated.
   4. Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
   5. I-Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges full depth of joist. Nailing flanges provide lateral support at joist top chord.
   6. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
   7. Bridging: Rigid, V-section, nailless type, 0.050 inch (1.3 mm) thick, length to suit joist size and spacing.
   8. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch (25 mm) above base and with 2-inch- (50-mm-) minimum side cover, socket 0.062 inch (1.6 mm) thick, and standoff and adjustment plates 0.108 inch (2.8 mm) thick.
   9. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
   10. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to side of rafter or truss, face of top plates, and side of stud below.
   11. Rafter Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, 2-1/4 inches (57 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.

12. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick by 36 inches (914 mm) long.
13. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.
14. Wall Bracing:
    a. T-shaped bracing made for letting into studs in saw kerf, 1-1/8 inches (29 mm) wide by 9/16 inch (14 mm) deep by 0.034 inch (0.85 mm) thick with hemmed edges.
       OR
       Wall Bracing: Angle bracing made for letting into studs in saw kerf, 15/16 by 15/16 by 0.040 inch (24 by 24 by 1 mm) thick with hemmed edges.

K. Miscellaneous Materials
1. Sill-Sealer Gaskets:
    a. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch (25-mm) nominal thickness, compressible to 1/32 inch (0.8 mm); selected from manufacturer's standard widths to suit width of sill members indicated.
       OR
       Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.
2. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
    a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

1.3 EXECUTION

A. Installation, General
1. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
4. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
5. Do not splice structural members between supports, unless otherwise indicated.
6. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
    a. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
7. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
    a. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
    b. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not

inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.

- c. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
- d. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.

8. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
9. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
    - a. Use inorganic boron for items that are continuously protected from liquid water.
    - b. Use copper naphthenate for items not continuously protected from liquid water.
10. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
    - a. NES NER-272 for power-driven fasteners.
    - b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
    - c. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's Uniform Building Code.
    - d. Table 2305.2, "Fastening Schedule," in BOCA's BOCA National Building Code.
    - e. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    - f. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
    - g. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.
11. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.
12. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
    - a. Comply with approved **OR** indicated, **as directed,** fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
    - b. Use finishing nails, unless otherwise indicated. Do not countersink nail heads **OR** Countersink nail heads and fill holes with wood filler, **as directed**.

B. Wood Ground, Sleeper, Blocking, And Nailer Installation

1. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
3. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

C. Wood Furring Installation

1. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
2. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally **OR** vertically **OR** horizontally and vertically, **as directed,** at 24 inches (610 mm) **OR** 600 mm, **as directed,** o.c.

3. Furring to Receive Gypsum Board **OR** Plaster Lath, **as directed**: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) **OR** 400 mm, **as directed,** o.c.

D. Wall And Partition Framing Installation
1. General: Provide single bottom plate and double top plates using members of 2-inch nominal (38-mm actual) thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction, unless otherwise indicated.
    a. For exterior walls, provide 2-by-6-inch nominal- (38-by-140-mm actual-) **OR** 2-by-4-inch nominal- (38-by-89-mm actual-), **as directed,** size wood studs spaced 24 inches (610 mm) **OR** 16 inches (406 mm) **OR** 600 mm **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
    b. For interior partitions and walls, provide 2-by-6-inch nominal- (38-by-140-mm actual-) **OR** 2-by-4-inch nominal- (38-by-89-mm actual-) **OR** 2-by-3-inch nominal- (38-by-64-mm actual-), **as directed**, size wood studs spaced 24 inches (610 mm) **OR** 16 inches (406 mm) **OR** 600 mm **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
    c. Provide continuous horizontal blocking at midheight of partitions more than 96 inches (2438 mm) high, using members of 2-inch nominal (38-mm actual) thickness and of same width as wall or partitions.
2. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.
3. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
    a. For non-load-bearing partitions, provide double-jamb studs and headers not less than 4-inch nominal (89-mm actual) depth for openings 48 inches (1200 mm) and less in width, 6-inch nominal (140-mm actual) depth for openings 48 to 72 inches (1200 to 1800 mm) in width, 8-inch nominal (184-mm actual) depth for openings 72 to 120 inches (1800 to 3000 mm) in width, and not less than 10-inch nominal (235-mm actual) depth for openings 10 to 12 feet (3 to 3.6 m) in width.
    b. For load-bearing walls, provide double-jamb studs for openings 60 inches (1500 mm) and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated or, if not indicated, according to Table R502.5(1) or Table R502.5(2), as applicable, in ICC's International Residential Code for One- and Two-Family Dwellings.
4. Provide diagonal bracing in exterior walls, at both walls of each external corner **OR** walls, at locations indicated, **as directed**, at 45-degree angle, full-story height, unless otherwise indicated. Use 1-by-4-inch nominal- (19-by-89-mm actual-) size boards, let-in flush with faces of studs **OR** metal wall bracing, let into studs in saw kerf, **as directed**.

E. Floor Joist Framing Installation
1. General: Install floor joists with crown edge up and support ends of each member with not less than 1-1/2 inches (38 mm) of bearing on wood or metal, or 3 inches (76 mm) on masonry. Attach floor joists as follows:
    a. Where supported on wood members, by toe nailing or by using metal framing anchors.
    b. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.
2. Fire Cuts: At joists built into masonry, bevel cut ends 3 inches (76 mm) and do not embed more than 4 inches (102 mm).
3. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches (1200 mm).
4. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than 1/3 depth of joist; do not locate closer than 2 inches (50 mm) from top or bottom.
5. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist at ends of joists unless nailed to header or band.

6. Lap members framing from opposite sides of beams, girders, or partitions not less than 4 inches (102 mm) or securely tie opposing members together. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist over supports.
7. Anchor members paralleling masonry with 1/4-by-1-1/4-inch (6.4-by-32-mm) metal strap anchors spaced not more than 96 inches (2438 mm) o.c., extending over and fastening to 3 joists. Embed anchors at least 4 inches (102 mm) into grouted masonry with ends bent at right angles and extending 4 inches (102 mm) beyond bend.
8. Provide solid blocking between joists under jamb studs for openings.
9. Under non-load-bearing partitions, provide double joists separated by solid blocking equal to depth of studs above.
    a. Provide triple joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures.
10. Provide bridging of type indicated below, at intervals of 96 inches (2438 mm) o.c., between joists.
    a. Diagonal wood bridging formed from bevel-cut, 1-by-3-inch nominal- (19-by-64-mm actual-) size lumber, double-crossed and nailed at both ends to joists.
    b. Steel bridging installed to comply with bridging manufacturer's written instructions.

F. Ceiling Joist And Rafter Framing Installation
1. Ceiling Joists: Install ceiling joists with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.
    a. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate and nail to first joist or anchor with framing anchors or metal straps. Provide 1-by-8-inch nominal- (19-by-184-mm actual-) size or 2-by-4-inch nominal- (38-by-89-mm actual-) size stringers spaced 48 inches (1200 mm) o.c. crosswise over main ceiling joists.
2. Rafters: Notch to fit exterior wall plates and toe nail or use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
    a. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches (50 mm) deeper. Bevel ends of jack rafters for full bearing against valley rafters.
    b. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches (50 mm) deeper. Bevel ends of jack rafters for full bearing against hip rafter.
3. Provide collar beams (ties) as indicated or, if not indicated, provide 1-by-6-inch nominal- (19-by-140-mm actual-) size boards between every third pair of rafters, but not more than 48 inches (1219 mm) o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.
4. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions, if any.

G. Timber Framing Installation
1. Install timber with crown edge up and provide not less than 4 inches (102 mm) of bearing on supports. Provide continuous members, unless otherwise indicated; tie together over supports as indicated if not continuous.
2. Where beams or girders are framed into pockets of exterior concrete or masonry walls, provide 1/2-inch (13-mm) air space at sides and ends of wood members.
3. Install wood posts using metal anchors indicated.
4. Treat ends of timber beams and posts exposed to weather by dipping in water-repellent preservative for 15 minutes.

H. Stair Framing Installation
1. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:
    a. Stringer Size: 2-by-12-inch nominal- (38-by-286-mm actual-) size, minimum.

   b. Stringer Material: Laminated-veneer lumber **OR** parallel-strand lumber **OR** solid lumber, **as directed**.
   c. Notching: Notch stringers to receive treads, risers, and supports; leave at least 3-1/2 inches (89 mm) of effective depth.
   d. Stringer Spacing: At least 3 stringers for each 36-inch (914-mm) clear width of stair.
2. Provide stair framing with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.

I. Protection
1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00 00

SECTION 06 10 53 00 – MISCELLANEOUS ROUGH CARPENTRY

1.1 GENERAL

A. Description Of Work:
  1. This specification covers the furnishing and installation of materials for miscellaneous carpentry. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. This Section includes the following:
    a. Framing with dimension lumber.
    b. Rooftop equipment bases and support curbs.
    c. Wood blocking, cants, and nailers.
    d. Wood furring and grounds.
    e. Wood sleepers.
    f. Interior wood trim.
    g. Wood shelving and clothes rods.
    h. Plywood backing panels.

C. Definitions
  1. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
  2. Lumber grading agencies, and the abbreviations used to reference them, include the following:
    a. NeLMA: Northeastern Lumber Manufacturers' Association.
    b. NHLA: National Hardwood Lumber Association.
    c. NLGA: National Lumber Grades Authority.
    d. SPIB: The Southern Pine Inspection Bureau.
    e. WCLIB: West Coast Lumber Inspection Bureau.
    f. WWPA: Western Wood Products Association.

D. Submittals
  1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
    a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
    b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
    c. For fire-retardant treatments specified to be High-Temperature (HT) type include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
    d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
    e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
  2. LEED Submittals:
    a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
    b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.

- c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
  - 1) Include statement indicating costs for each certified wood product.
- 3. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
  - a. Preservative-treated wood.
  - b. Fire-retardant-treated wood.
  - c. Power-driven fasteners.
  - d. Powder-actuated fasteners.
  - e. Expansion anchors.
  - f. Metal framing anchors.

E. Quality Assurance

- 1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
  - a. Dimension lumber framing.
  - b. Miscellaneous lumber.
  - c. Interior wood trim.
  - d. Shelving and clothes rods.

F. Delivery, Storage, And Handling

- 1. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- 2. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

1.2 PRODUCTS

A. Wood Products, General

- 1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  - a. Factory mark each piece of lumber with grade stamp of grading agency.
  - b. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
  - c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
  - d. Provide dressed lumber, S4S, unless otherwise indicated.

B. Wood-Preservative-Treated Materials

- 1. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
  - a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
  - b. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
    a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
4. Application: Treat all miscellaneous carpentry, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
    a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
    b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
    c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
    d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawl spaces or unexcavated areas.
    e. Wood floor plates that are installed over concrete slabs-on-grade.

C. Fire-Retardant-Treated Materials
1. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
    a. Use treatment that does not promote corrosion of metal fasteners.
    b. Use Exterior type for exterior locations and where indicated.
    c. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
    d. Use Interior Type A, unless otherwise indicated.
2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
    a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
4. Application: Treat all miscellaneous carpentry, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
    a. Framing for raised platforms.
    b. Concealed blocking.
    c. Roof construction.
    d. Plywood backing panels.

D. Dimension Lumber Framing
1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Non-Load-Bearing Interior Partitions: Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
3. Other Framing: No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No., **as directed**, grade and any of the following species:
    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Mixed southern pine; SPIB.
    e. Spruce-pine-fir; NLGA.
    f. Douglas fir-south; WWPA.
    g. Hem-fir; WCLIB or WWPA.

    h. Douglas fir-larch (north); NLGA.
    i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

E. Miscellaneous Lumber
  1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
    a. Blocking.
    b. Nailers.
    c. Rooftop equipment bases and support curbs.
    d. Cants.
    e. Furring.
    f. Grounds.
    g. Utility shelving.
  2. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed**, percent maximum moisture content of any species.
  3. For exposed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
    a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or 2 Common (Sterling) **OR** Standard or No. 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
    b. Mixed southern pine, No. 1 **OR** 2, **as directed**, grade; SPIB.
    c. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
    d. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
  4. For concealed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
    a. Mixed southern pine, No. 2 **OR** 3, **as directed**, grade; SPIB.
    b. Hem-fir or hem-fir (north), Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
    c. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
    d. Eastern softwoods, No. 2 **OR** 3, **as directed**, Common grade; NELMA.
    e. Northern species, No. 2 **OR** 3, **as directed**, Common grade; NLGA.
    f. Western woods, Construction or No. 2 Common **OR** Standard or No. 3 Common, **as directed**, grade; WCLIB or WWPA.
  5. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
  6. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
  7. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

F. Interior Wood Trim
  1. General: Provide kiln-dried finished (surfaced) material without finger-jointing, unless otherwise indicated.
  2. Softwood Lumber Trim for Transparent (Stain or Clear) Finish: Provide one of the following species and grade:
    a. Grade C Select **OR** D Select **OR** Finish **OR** Premium, **as directed**, eastern white pine; NeLMA or NLGA.
    b. Grade C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**, Idaho white, lodgepole, ponderosa, or sugar pine; NLGA or WWPA.
    c. Grade Superior or C & Btr **OR** Prime or D, **as directed**, Finish Douglas fir-larch or Douglas fir-south; NLGA, WCLIB, or WWPA.

        - d. Clear Heart **OR** Grade A **OR** Grade B, **as directed**, western red cedar; NLGA, WCLIB, or WWPA.
    3. Hardwood Lumber Trim for Transparent (Stain or Clear) Finish: Clear red oak **OR** white maple, **as directed**, selected for compatible grain and color, **as directed**.
    4. Lumber Trim for Opaque (Painted) Finish: Either finger-jointed or solid lumber, of one of the following species and grades:
        - a. Grade D Select **OR** Finish **OR** Premium, **as directed**, eastern white pine; NeLMA or NLGA.
        - b. Grade D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**, Idaho white, lodgepole, ponderosa, or sugar pine; NLGA or WWPA.
        - c. Grade A **OR** B, **as directed**, Finish aspen, basswood, cottonwood, gum, magnolia, red alder, soft maple, sycamore, tupelo, or yellow poplar; NHLA.
    5. Moldings: Made to patterns included in WMMPA WM 7 and graded according to WMMPA WM 4.
        - a. Moldings for Transparent (Stain or Clear) Finish: N-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine **OR** western red cedar **OR** Douglas fir **OR** red oak **OR** white maple, **as directed**, selected for compatible grain and color.
        - b. Moldings for Opaque (Painted) Finish: P-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine **OR** aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar **OR** primed medium-density fiberboard, **as directed**.

G. Shelving And Clothes Rods
    1. Shelving: Made from one of the following materials, 3/4-inch (19-mm) thick. Do not use particleboard or medium-density fiberboard that contains urea formaldehyde.
        - a. Melamine-faced particleboard with radiused and filled front edge.
        - b. Particleboard with radiused and filled **OR** solid-wood, **as directed**, front edge.
        - c. Medium-density fiberboard with radiused **OR** solid-wood, **as directed**, front edge.
        - d. Wood boards of same species and grade indicated above for interior lumber trim for opaque **OR** transparent, **as directed**, finish.
    2. Shelf Cleats: 3/4-by-3-1/2-inch (19-by-89-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards with hole and notch to receive clothes rods, **as directed**, of same species and grade indicated above for interior lumber trim for opaque finish.
    3. Shelf Brackets: Prime-painted formed steel with provision to support clothes rod where rod is indicated.
    4. Clothes Rods:
        - a. 1-1/2-inch- (38-mm-) diameter, clear, kiln-dried hardwood rods **OR** clear, kiln-dried softwood rods; either Douglas fir or southern pine **OR** aluminum tubes, **as directed**.
          OR
          1-1/4-inch- (32-mm-) diameter, chrome-plated steel **OR** stainless-steel, **as directed**, tubes.
    5. Rod Flanges: Clear, kiln-dried hardwood turnings **OR** Clear, kiln-dried softwood turnings **OR** Aluminum **OR** Chrome-plated steel **OR** Stainless steel, **as directed**.

H. Plywood Backing Panels
    1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, **as directed**, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

I. Fasteners
    1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
        - a. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
    2. Nails, Brads, and Staples: ASTM F 1667.
    3. Power-Driven Fasteners: NES NER-272.
    4. Wood Screws: ASME B18.6.1.
    5. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

6. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
7. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
8. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
    a. Material:
        1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
           OR
           Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

J. Metal Framing Anchors
1. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
    a. Use for interior locations where stainless steel is not indicated.
2. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
    a. Use for exterior locations and where indicated.

K. Miscellaneous Materials
1. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
    a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Installation, General
1. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
4. Do not splice structural members between supports, unless otherwise indicated.
5. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
    a. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
6. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
    a. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
    b. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.
    c. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.

    - d. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
  - 7. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
  - 8. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
    - a. Use inorganic boron for items that are continuously protected from liquid water.
    - b. Use copper naphthenate for items not continuously protected from liquid water.
  - 9. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
    - a. NES NER-272 for power-driven fasteners.
    - b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
    - c. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's Uniform Building Code.
    - d. Table 2305.2, "Fastening Schedule," in BOCA's BOCA National Building Code.
    - e. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    - f. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
    - g. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.
  - 10. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

- B. Wood Ground, Sleeper, Blocking, And Nailer Installation
  - 1. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
  - 2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
  - 3. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

- C. Wood Furring Installation
  - 1. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
  - 2. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally **OR** vertically **OR** horizontally and vertically, **as directed**, at 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c.
  - 3. Furring to Receive Gypsum Board **OR** Plaster Lath, **as directed**: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) **OR** 400 mm, **as directed**, o.c.

- D. Wood Trim Installation
  - 1. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints.
    - a. Match color and grain pattern across joints.
    - b. Install trim after gypsum board joint-finishing operations are completed.
    - c. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads and fill holes.

d. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.6-mm) maximum offset for reveal installation.

E. Protection

1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 53 00

SECTION 06 11 13 00 – ROUGH CARPENTRY RENOVATION

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for rough carpentry renovation. Products shall be as approved by The University. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Quality Assurance
  1. Regulatory Requirements:
    a. Fire Retardant Treated Lumber and Plywood: Bear UL FR-S classification label.
    b. Preservative Treated Wood: Provide all heart redwood, cedar, or cyprus; or preservative-treated wood at following conditions in accordance with applicable building code:
      1) Wood framing, woodwork, and plywood up to and including subflooring at first-floor level of structures having crawl spaces, when bottoms of such items are 150 mm (6 inches) or less from earth underneath.
      2) Exterior wood steps, platforms, and railings.
      3) Wood sills, soles, plates, furring, and sleepers that are less than 150 mm (6 inches) from earth, furring and nailers that are set into or in contact with concrete or masonry.
      4) Nailers, edge strips, crickets, curbs, and cants for roof decks.
      5) Furring strips used on walls or partitions below grade and exterior walls above grade.
      6) Wood members used for rough framing of openings in exterior concrete or masonry walls.

B. Delivery, Storage, And Handling
  1. General: Deliver material to site, off-load, and handle in manner that will not damage material. Store material off ground and cover with waterproof covering. Provide adequate ventilation.
    a. Interior Fire-Retardant Treated Wood: Keep dry at all times. Replace material that has become wet. Store off ground, in building, or covered with unbroken water-tight cover in storage yard, during transit, and at job site. Keep ventilated to avoid moisture condensation.

C. Project Conditions
  1. Environmental Requirements: Execute demolition and renovation in manner to limit unnecessary dust and noise, and in compliance with applicable codes and federal or state requirements. Burning of materials on site not allowed.
  2. Existing Conditions: See Detailed Scope of Work. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
  3. Protection:
    a. Provide necessary temporary shoring and bracing to support and protect portions of existing buildings during demolition operations. Leave such shoring in place until permanent supports have been installed. Be solely responsible for design, safety, and adequacy of temporary shoring and bracing and its ability to carry load for which intended.
    b. Contractor: Protect grounds, plantings, buildings, and any other facilities or property from damage caused by construction operations.
  4. Safety: Cease operations at endangered area, and notify The University immediately if safety of structure appears to be endangered. Take precautions to properly support structure. Do not resume work in endangered area until safety is restored.

D. Scheduling And Sequencing
  1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

1.3 PRODUCTS

A. Materials
- 1. Materials for Patching, Extending, and Matching:
  - a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
    - 1) Generally, Contract Documents will not define products or standards of workmanship present in existing construction. Determine products by inspection and testing as ecessary, and required workmanship by reference to existing as sample of comparison.
    - 2) Patching, extending, and matching existing work and systems shall result in complete, finished system.
  - b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.
- 2. Lumber: Each Piece of Lumber: Grade stamped by recognized association or independent inspection agency certified by American Lumber Standards Committee's Board of Review.
  - a. New Replacement Studs and Joists: Match existing and complies with Reference Standards.
  - b. Wood Studs and Joists: No. 2 Grade or better.
  - c. Sill Plates on Concrete: All heart redwood, cedar, or cyprus: or preservative-treated wood.
  - d. Blocking and Furring: Standard Grade or Better.
  - e. Preservative-Treated: AWPB LP-2, pressure-treated with waterborne preservative. Penta or creosote not allowed.
    - 1) Treat drilled holes and cuts across grain in accordance with AWPA M4.
  - f. Fire-Retardant Treated:
    - 1) Lumber: AWPA C20 Interior Type A.
    - 2) Plywood: AWPA C27 Interior Type A.
    - 3) Bear UL FR-S classification label.
  - g. Pressure-Treated Lumber: Bear AWPA Quality Mark C-2.
  - h. Seasoning: Kiln dry to following (including treated material):
  - i. Lumber Up to 50 mm (2 inches): 19 percent or less moisture content.
  - j. Preservative- and Fire-Retardant Treated Material: Mill or rip material parallel to grain prior to treatment.
- 3. Plywood: PS-1: Each panel identified with APA grade trademark.
  - a. Subfloor: APA Rated Sheathing, Tongue and groove, Exposure 1 (interior with exterior glue).
    - 1) Span Rating: Not less than spacing of framing members.
    - 2) Thickness: In accordance with APA Recommendations.
  - b. Roof Sheathing: APA Rated Sheathing, Exposure 1 (interior with exterior glue).
    - 1) Span Rating: Not less than spacing of framing members.
    - 2) Thickness: In accordance with APA Recommendations.
  - c. Wall Sheathing: APA CD, Exposure 1 (Interior with exterior glue).
    - 1) Span Rating: Not less than spacing of framing members.
    - 2) Thickness: As indicated.
  - d. Panel Edge Clips: Extruded aluminum or hot-dipped galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.
  - e. Fire-Retardant Treated Plywood: Bear UL FR-S classification label.
    - 1) Interior Plywood Fire Retardant Treatment: AWPA C27 Interior Type A.
    - 2) Exterior Plywood Fire Retardant Treatment: AWPA C27 Exterior Type.
  - f. Seasoning: Kiln dry plywood to 15 percent or less moisture content.
    - 1) Pressure Treated Plywood: Kiln dry lumber after treatment.
  - g. Nails: Type and size as recommended by APA.
- 4. Metal Framing Anchors: Punched and formed for nailing so that nails will be stressed in shear only.
  - a. General: Provide with nails and bolts according to manufacturers requirements.
    - 1) Nails: Zinc coated.

    - b. Types: As indicated and as required to accommodate framing.
    - c. Sizes: Of sufficient size and strength to develop full strength of supported member in accordance with applicable building code.
    - d. Metal Bridging: Minimum No. 16 U.S. Standard gage.
    - e. Finish: Hot-dipped galvanized.
  - 5. Anchor Bolts: Furnish anchors to be built into concrete and masonry for anchorage of wood.
  - 6. Rough Hardware: Provide necessary bolts, screws, nails, clips, plates, straps, hangers, etc., necessary for completion of renovation work. Provide correct material of proper size and strength for purpose intended, conforming to Reference Standards and applicable building codes.
    - a. Exterior Locations and for Fire-Retardant- and Preservative-Treated Wood: Provide galvanized rough hardware.
  - 7. Vapor Barrier at Crawl Spaces: ASTM D 2103, 0.15 mm (6 mil) polyethylene sheeting.
  - 8. Insulation: Type and R-value to comply with applicable codes and regulations.
    - a. Blanket Insulation: ASTM C 665 fiberglass blankets. Exposed insulation shall be foil-faced with flame-spread rating of 25 or less in accordance with ASTM E 84, where required by applicable codes and regulations.

1.4 EXECUTION

A. Examination
  - 1. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
    - a. Verify that surfaces to receive rough carpentry are prepared to require grades and dimensions.

B. Preparation
  - 1. Dust Protection: Comply with Detailed Scope of Work.
  - 2. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
  - 3. Protection: See Detailed Scope of Work.
  - 4. Selective Demolition: Comply with Detailed Scope of Work.

C. Laying Out Work
  - 1. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
    - a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
    - b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to The University for adjustment before work affected is performed.
      - 1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
  - 2. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

D. Performance
  - 1. Patching: Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship.
    - a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
  - 2. General: Perform in accordance with AF&PA National Design Specification for Wood Construction, latest Edition.
    - a. Framing: Erect plumb, level and true and rigidly anchor in place. Cut framing square on bearings, closely fit, accurately set to required lines and levels.
    - b. Nail or spike members in accordance with applicable codes.
    - c. Framing: 400 mm (16 inches) OC unless otherwise indicated.
    - d. Shims: Do not use shims for leveling on wood or metal bearings. Use steel or slate shims with full bearing on masonry or concrete.

- e. Do not splice framing members between bearing points.
- f. Metal Framing Anchors: Install where required for proper connections in accordance with manufacturer recommendations. Drive nail in each nail hole provided in anchor.

3. Wood Framing:
   - a. Openings: Frame members for passage of pipes and ducts to avoid cutting structural members. Do not cut, notch, or bore framing members for passage of pipes or conduits without The University’s permission. Reinforce framing members as directed where damaged by cuffing.
   - b. Firestopping: Firestop concealed spaces in framing. No shutoff by framing members to prevent drafts from one space to another. Use 50 mm (2 inch) nominal thick accurately fit wood blocking to fill opening.
   - c. Joists and Beams: Sizes and spacing as indicated.
     - 1) Set crown edge-up with 90 mm (3-1/2 inch) bearing unless noted otherwise.
     - 2) Toe nail joists to wood sills with 16d nails both sides or secure with metal connectors. Lap and spike joists over supports.
     - 3) Double joists to form headers and trimmers at openings over 1,200 mm (4 feet) and support with metal joist hangers.
     - 4) Provide joist hangers at joists framing into flush wood beams.
   - d. Provide blocking or suitable edge support between members as necessary to support edges of sheathing.
   - e. Replace warped lumber in walls and joists prior to installation of finish surface.
4. Anchors: Unless otherwise indicated, bolt plates firmly to concrete or masonry with anchor bolts in accordance with applicable code.
   - a. In Masonry: Embed anchor bolts minimum 400 mm (16 inches) and provide each with nut and 50 mm (2 inch) diameter washer at bottom end. Grout bolts with mortar.
   - b. In Concrete: Embed anchor bolts minimum 200 mm (8 inches) and provide each with nut and 50 mm (2 inch) diameter washer at bottom end. 90 degree bent end may be substituted for nut and washer.
5. Wood Studs: Install at 400 mm (16 inches) OC with single bottom plate and double top plate with joints staggered.
   - a. Double studs at openings and triple at corners and intersections. Double headers with double trimmers over openings.
6. Plywood Sheathing: Install in accordance with APA Recommendations.
   - a. Provide space at end and side joints as recommended by APA.
   - b. Install panels with face grain perpendicular to supports with end-joints supported. Stagger ends of adjacent sheets 1 200 mm (4 feet) where possible.
   - c. Where support spacing exceeds maximum span for unsupported edge, provide adequate blocking, tongue and groove edges, or panel edge clips, in accordance with APA E30-L.
   - d. Nail in accordance with APA's Recommendations.
7. Preservative- and Fire-Retardant Material: Milling or ripping material parallel to grain not allowed unless material is treated after milling or ripping.
   - a. Preservative-Treated Material: Treat drilled holes and cuts across grain in accordance with AWPA M4.

E. Flooring Work

1. Defective Joists and Subfloor: Remove defective joists and subfloor which no longer satisfy structural requirements with now material to fulfill their structural function.
   - a. Remove ceiling, subfloor, and joists in safe manner and at minimum inconvenience to residents.
   - b. Splice, strengthen, support, or replace rotted or otherwise defective joists to fulfill their anticipated structural function.
   - c. New Replacement Joists: Comply with requirements of appropriate section specifying new flooring, including flooring manufacturer’s recommendations.
   - d. Ceiling Replacement: Include removal and replacement of ceiling finish to match existing.
     - 1) Glue and screw new ceiling material to bottom of joists.

        2) Paint entire ceiling of space affected by replacement matching color of existing walls in accordance with Division 9 Section “Painting.”
    e. Crawl-Space Insulation: Replace insulation damaged by or removed during construction operations. If there is no existing insulation, provide new insulation, where required.
        1) Insulation: Type and R-value to comply with applicable codes and regulations.
    f. New Replacement Subfloor: Install in accordance with APA Recommendations and with requirements of appropriate section specifying new flooring, including flooring manufacturer’s recommendations.
        1) Glue and nail new subfloor to joists.
        2) Nail in accordance with APA’s Recommendations and sufficiently to avoid squeaking floors.
    g. Base at walls: Replace wood base (including coves and corner rounds) with new wood base to match existing.
2. Above-Grade Floors to Receive Resilient Flooring: Examine to ensure that vapor-barrier sheet is laid over ground, sheets lapped, edge joints sealed and sufficient cross ventilation exists to insure dryness.
    a. If vapor barrier does not cover ground in crawl space, install vapor barrier in accordance with applicable codes and regulations.
        1) Completely cover ground at crawl spaces with minimum 150 mm (6 inch) lapped joints.
        2) Tape all lapped joints with water-resistive tape in accordance with manufacturer's recommendations.
        3) Protect vapor barrier from puncture and displacement. Lay heavy objects such as pieces of masonry at intervals not over 1 200 mm (4 feet) OC at lapped joints to hold in place. If punctures occur in vapor barrier, repair by placing patches of vapor-barrier material over punctures and taping all lapped joints.
    b. If crawl space does not have enough ventilation, install additional vents in accordance with applicable codes and regulations.
3. Floors Damaged by Construction Operations: Patch floor damage to match existing floor surfaces, and comply with requirements for new flooring.

F. Roofing Work
1. Removal of Existing Roofing: Roofing may contain asbestos fibers. Comply with applicable codes, laws, and regulations regarding asbestos materials.
2. Defective Rafters and Sheathing: Remove defective rafters and sheathing which no longer satisfy structural requirements with new material to match existing.
    a. Remove sheathing and rafters in safe manner and at minimum inconvenience to residents.
    b. Splice, strengthen, support, or replace rotted or otherwise defective rafters to fulfill their anticipated structural function.
    c. New Replacement Sheathing: Install in accordance with APA Recommendations and with requirements of applicable Division 7 roofing Sections.
        1) Nail in accordance with APA s Recommendations.

G. Blocking And Furring
1. Blocking: Install wood blocking as required for proper support of hardware, bath accessories, cabinets, and other wall-mounted hems.
    a. Set true to line, level, or plumb, well-secured in stud wall and flush with back of drywall or other wall finish.
    b. Coordinate exact locations with other sections.
2. Rough Wood Bucks: Set true and plumb and anchor to concrete or masonry with steel straps extending into wall minimum 200 mm (8 inches). Place anchors near top and bottom of buck and space uniformly at maximum 600 mm (24 inches) OC. Provide nominal 50 mm (2 inch) thick if not indicated.
3. Wood Furring: Install wood furring on masonry or concrete walls in sizes and spacing as indicated on Drawings (if any). Provide minimum 25 mm by 75-mm (1 inch by 3 inch) nominal furring strips spaced at maximum of 400 mm (16 inches) OC if not indicated.

a. Securely fasten wood furring at maximum 900 mm (3 feet) OC with toggle or expansion bolts, cut concrete nails or ramset anchors as required. Do not use wood plugs.
b. Install furring around openings and at corners.
c. Erect furring plumb and level, and shim out as required to provide true, even plane with surfaces suitable to receive required finish.

END OF SECTION 06 11 13 00

SECTION 06 20 13 00 – EXTERIOR FINISH CARPENTRY

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for exterior finish carpentry. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
   a. Exterior standing and running trim.
   b. Lumber, Plywood, and Hardboard siding.
   c. Plywood and Hardboard soffits.
   d. Exterior stairs and railings.
   e. Exterior ornamental wood columns.

C. Definitions

1. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   a. NeLMA: Northeastern Lumber Manufacturers' Association.
   b. NLGA: National Lumber Grades Authority.
   c. RIS: Redwood Inspection Service.
   d. SPIB: The Southern Pine Inspection Bureau.
   e. WCLIB: West Coast Lumber Inspection Bureau.
   f. WWPA: Western Wood Products Association.

D. Submittals

1. Product Data: For each type of process and factory-fabricated product.
2. Samples: For each type of siding indicated.
3. LEED Submittal:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
4. Research/Evaluation Reports: For fire-retardant-treated wood.
5. Compliance Certificates:
   a. For lumber that is not marked with grade stamp.
   b. For preservative-treated wood that is not marked with treatment quality mark.
   c. For fire-retardant-treated wood that is not marked with classification marking of testing and inspecting agency.
6. Warranties: Special warranties specified in this Section.

E. Quality Assurance

1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
   a. Exterior standing and running trim.
   b. Exterior lumber, plywood, and hardboard siding.
   c. Exterior plywood and hardboard soffits.
   d. Exterior stairs and railings.
   e. Exterior ornamental wood columns.

F. Delivery, Storage, And Handling

1. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.

G. Warranty
  1. Special Warranty for Cellular PVC Trim: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace trim that fails due to defects in manufacturing within 25 years from date of Substantial Completion. Failures include, but are not limited to rotting, corrosion, delamination, and excessive swelling from moisture.
  2. Special Warranty for Hardboard Siding and Trim: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace siding that fails in materials or workmanship within specified warranty period. Failures include, but are not limited to, deformation or deterioration beyond normal weathering.
    a. Warranty Period for Factory-Applied Finish: Five years from date of Substantial Completion.
    b. Warranty Period for Siding and Trim (Excluding Finish): 25 years from date of Substantial Completion.
  3. Special Warranty for Columns: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace columns that fail in materials or workmanship within five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials, General
  1. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
  2. Softwood Plywood: DOC PS 1.
  3. Hardboard: AHA A135.4.

B. Wood-Preservative-Treated Materials
  1. Water-Repellent Preservative Treatment by Nonpressure Process: AWPA N1 (dip, spray, flood, or vacuum-pressure treatment).
    a. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC), combined with an insecticide containing chloropyrifos (CPF).
    b. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.
    c. Application: Items not required to be pressure-preservative treated.
    d. Application: Exterior trim and wood siding.
  2. Preservative Treatment by Pressure Process:
    a. Lumber: AWPA C2 except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX). Kiln dry after treatment to a maximum moisture content of 19 percent.
    b. Plywood: AWPA C9. Kiln dry after treatment to a maximum moisture content of 18 percent.
    c. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
    d. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
    e. Do not use material that is warped or does not comply with requirements for untreated material.
    f. Mark lumber with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
      1) For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

        g. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
            1) For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
        h. Application: Where indicated **OR** All exterior lumber and plywood, **as directed**.

C. Fire-Retardant-Treated Materials
    1. Lumber: Comply with performance requirements in AWPA C20, Exterior type. Kiln dry after treatment to a maximum moisture content of 19 percent.
    2. Plywood: Comply with performance requirements in AWPA C27, Exterior type. Kiln dry after treatment to a maximum moisture content of 15 percent.
    3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants and provide materials that do not have marks from spacer sticks on the exposed face.
    4. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
    5. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
        a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
        b. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
    6. Application: Where indicated **OR** All exterior lumber and plywood, **as directed**.

D. Standing And Running Trim
    1. Lumber Trim for Semitransparent-Stained Finish **OR** Clear Finish **OR** Unfinished Applications, **as directed**:
        a. Species and Grade: Redwood, Clear All Heart **OR** Hart B **OR** Clear **OR** Grade B, **as directed**; RIS.
        b. Species and Grade: Western red cedar, Clear Heart VG (Vertical Grain) **OR** Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
        c. Species and Grade: Hem-fir, pressure-preservative treated; 1 **OR** 2, **as directed**, Common; NLGA, WCLIB, or WWPA.
        d. Species and Grade: Southern pine, pressure-preservative treated; B & B **OR** C & Btr **OR** D, **as directed**; SPIB.
        e. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
        f. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
        g. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
    2. Lumber Trim for Opaque-Stained **OR** Painted, **as directed**, Finish:
        a. Species and Grade: Redwood, Clear **OR** Grade B, **as directed**; RIS.
        b. Species and Grade: Western red cedar, Grade A **OR** B, **as directed**; NLGA, WCLIB, or WWPA.
        c. Species and Grade: Hem-fir, Prime or D finish **OR** 1 Common **OR** 2 Common, **as directed**; NLGA, WCLIB, or WWPA.
        d. Species and Grade: Eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, WCLIB, or WWPA.
        e. Species and Grade: Northern white cedar, D Select **OR** 1 Common **OR** 2 Common, **as directed**; NeLMA or NLGA.
        f. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
        g. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.

   h. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
3. Moldings for Semitransparent-Stained Finish **OR** Clear Finish **OR** Unfinished Applications, **as directed**: WMMPA WM 4, N-grade wood moldings, without finger jointing. Made from kiln-dried stock to patterns included in WMMPA WM 12.
   a. Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine, **as directed**.
   b. Brick-Mold Pattern: WM 180, 1-1/4 by 2 inches (32 by 51 mm).
   c. Drip-Cap Pattern: WM 197, 11/16 by 1-5/8 inches (17 by 41 mm).
   d. Bed-Mold Pattern: WM 75, 9/16 by 1-5/8 inches (14 by 41 mm).
   e. Screen-Bead Pattern: WM 144, 1/4 by 3/4 inch (6 by 19 mm).
4. Moldings for Opaque-Stained **OR** Painted, **as directed**, Finish: WMMPA WM 4, P-grade wood moldings. Made from kiln-dried stock to patterns included in WMMPA WM 12.
   a. Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine, **as directed**.
   b. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
   c. Brick-Mold Pattern: WM 180, 1-1/4 by 2 inches (32 by 51 mm).
   d. Drip-Cap Pattern: WM 197, 11/16 by 1-5/8 inches (17 by 41 mm).
   e. Bed-Mold Pattern: WM 75, 9/16 by 1-5/8 inches (14 by 41 mm).
   f. Screen-Bead Pattern: WM 144, 1/4 by 3/4 inch (6 by 19 mm).

E. Lumber Siding
1. Provide kiln-dried lumber siding complying with DOC PS 20, factory coated with exterior alkyd primer, **as directed**.
2. Species and Grade:
   a. Clear All Heart VG **OR** Clear All Heart **OR** Clear VG (Vertical Grain) **OR** Clear **OR** Grade B, **as directed**, redwood; RIS.
   b. Clear VG (Vertical Grain) Heart **OR** Grade A **OR** Grade B, **as directed** western red cedar; NLGA, WCLIB, or WWPA.
   c. Grade 1 **OR** 2, **as directed**, Common spruce-pine-fir; NeLMA, NLGA, WCLIB, or WWPA.
   d. Grade Prime or D finish **OR** 1 Common **OR** 2 Common, **as directed**, pressure-preservative-treated hem-fir; NLGA, WCLIB, or WWPA.
   e. Grade D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**, eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; NeLMA, NLGA, WCLIB, or WWPA.
   f. Grade D Select **OR** 1 Common **OR** 2 Common, **as directed**, northern white cedar; NeLMA or NLGA.
   g. Grade B & B **OR** C & Btr **OR** D **OR** 1 Common **OR** 2 Common, **as directed**, pressure-preservative-treated southern pine; SPIB.
3. Pattern:
   a. Bevel siding, S1S2E, actual overall dimensions of 5-1/2 by 11/16 inch (140 by 17 mm) **OR** 5-1/2 by 3/4 inch (140 by 19 mm) **OR** 7-1/4 by 3/4 inch (184 by 19 mm) **OR** 9-1/4 by 3/4 inch (235 by 19 mm) **OR** 9-1/4 by 1-3/32 inches (235 by 28 mm), **as directed**, measured on the face and thick edge at 19 percent moisture content.
   b. Drop siding, SPIB or WWPA pattern No. 105, actual face width (coverage) and thickness of 4-7/8 by 9/16 inch (124 by 14 mm) **OR** 4-7/8 by 23/32 inch (124 by 18 mm) **OR** 6-5/8 by 23/32 inch (168 by 18 mm) **OR** 8-5/8 by 23/32 inch (219 by 18 mm), **as directed**, measured at 19 percent moisture content.
   c. V-edge, smooth-faced tongue-and-groove pattern with eased edges, actual face width (coverage) and thickness of 3-1/8 by 9/16 inch (79 by 14 mm) **OR** 3-1/8 by 23/32 inch (79 by 18 mm) **OR** 5-1/8 by 23/32 inch (130 by 18 mm) **OR** 6-7/8 by 23/32 inch (175 by 18 mm), **as directed**, measured at 19 percent moisture content.

F. Plywood Siding
1. Plywood Type: APA-rated siding, pressure-preservative treated, **OR** factory coated with exterior acrylic latex stain, **as directed**, in panel sizes indicated.

a. Face Grade: 303-OC **OR** OL **OR** NR **OR** SR, **as directed**.
b. Face Grade: 303-6 **OR** 18 **OR** 30, **as directed**-S **OR** W **OR** S/W, **as directed**.

2. Thickness: 11/32 inch (8.7 mm) **OR** 3/8 inch (9.5 mm) **OR** 15/32 inch (11.9 mm) **OR** 1/2 inch (12.7 mm) **OR** 19/32 inch (15.1 mm) **OR** 5/8 inch (15.9 mm) **OR** As indicated, **as directed**.
3. Face Species: Southern pine **OR** Douglas fir **OR** Western red cedar **OR** Redwood, **as directed**.
4. Pattern: Plain **OR** Channel groove; grooves 4 inches (101.6 mm) o.c. **OR** Texture 1-11; grooves 4 inches (101.6 mm) o.c. **OR** Reverse board-and-batten; grooves 12 inches (304.8 mm) o.c., **as directed.**
5. Surface: Smooth **OR** Rough sawn, **as directed**.

G. Hardboard Soffits

1. Hardboard Soffits: Primed hardboard, complying with AHA A135.6, with manufacturer's standard exterior primer.
   a. Type: 7/16-inch- (11-mm-) **OR** 1/2-inch- (12.7-mm-), **as directed**, thick flat panels, smooth **OR** wood-grain textured **OR** stucco textured, **as directed**.
2. Colors, Textures, and Patterns: As selected by The University from manufacturer's full range.

H. Stairs And Railings

1. Stairs:
   a. Treads: 1-1/4-inch (32-mm) thick, kiln-dried, pressure-preservative-treated stepping with half-round or rounded edge nosing.
      1) Species and Grade: Douglas fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA **OR** Hem-fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA **OR** Southern pine, B & B stepping; SPIB, **as directed**.
   b. Risers: 3/4-inch (19-mm) thick, kiln-dried, pressure-preservative-treated finish boards.
      1) Species and Grade: Douglas fir, C & Btr or Superior finish; NLGA, WCLIB, or WWPA **OR** Hem-fir, C & Btr or Superior finish; NLGA, WCLIB, or WWPA **OR** Southern pine, B & B; SPIB, **as directed**
2. Railings: Clear, kiln-dried, solid, yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**; railing stock of pattern indicated.
3. Balusters: 1-1/16-inch- (27-mm-) square, clear, kiln-dried, solid, yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**.
4. Newel Posts: Clear, kiln-dried, yellow poplar **OR** pressure-preservative-treated, Douglas fir **OR** pressure-preservative-treated, southern pine, **as directed**, turned newel posts of pattern and size indicated.
5. Newel Posts: 2-3/4-inch- (70-mm-) square, clear, kiln-dried yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**; either solid or laminated.

I. Ornamental Wood Columns

1. Factory fabricate columns from clear stock, either solid or finger jointed, with a moisture content of not more than 15 **OR** 19, **as directed**, percent.
   a. Wood Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, or sugar pine, **as directed**.
2. Shafts: Built up from tongue-and-groove staves joined with waterproof glue. Lathe turn shafts to provide base diameter indicated and true architectural entasis taper. Precisely mill flutes as indicated.
3. Capital and Base: Molded glass-fiber-reinforced plastic **OR** Built up from wood components with waterproof glue. Turn circular elements on lathes.
4. Plinths: Cast-aluminum or molded glass-fiber-reinforced plastic, constructed to ventilate the interior of column shaft.
5. Treatment and Finishing:
   a. Treat wood columns with water-repellant preservative by nonpressure process.
   b. Coat inside of column shafts with bituminous mastic.
   c. Prime columns with two coats of exterior alkyd wood primer compatible with specified topcoats.

J. Miscellaneous Materials
  1. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
    a. For face-fastening siding, provide ringed-shank siding nails unless hot-dip galvanized nails are used.
    b. For redwood, provide brass/bronze **OR** stainless-steel **OR** hot-dip galvanized steel, **as directed**, fasteners.
    c. For prefinished items, provide matching prefinished aluminum fasteners where face fastening is required.
    d. For pressure-preservative-treated wood, provide stainless-steel **OR** hot-dip galvanized steel, **as directed**, fasteners.
    e. For applications not otherwise indicated, provide stainless-steel **OR** hot-dip galvanized steel **OR** aluminum, **as directed**, fasteners.
  2. Wood Glue: Waterproof resorcinol glue recommended by manufacturer for exterior carpentry use.
  3. Adhesive for Cellular PVC Trim: Product recommended by trim manufacturer.
  4. Flashing: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing materials installed in exterior finish carpentry.
    a. Horizontal Joint Flashing for Panel Siding: Preformed, galvanized steel **OR** aluminum **OR** prefinished aluminum **OR** stainless-steel, **as directed**, Z-shaped flashing.
  5. Insect Screening for Soffit Vents: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh **OR** PVC-coated glass-fiber fabric, 18-by-14 (1.4-by-1.8-mm) or 18-by-16 (1.4-by-1.6-mm) mesh **OR** Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, **as directed**.
  6. Continuous Soffit Vents: Aluminum hat channel shape with stamped louvers **OR** perforations, **as directed**, 2 inches (51 mm) wide, and in lengths not less than 96 inches (2438 mm).
    a. Net Free Area: 4 sq. in./linear ft. (280 sq. cm/m) **OR** 6 sq. in./linear ft. (420 sq. cm/m) **OR** 8 sq. in./linear ft. (560 sq. cm/m), **as directed**.
    b. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
  7. Round Soffit Vents: Stamped aluminum louvered vents, 2 inches (51 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, made to be inserted into round holes cut into soffit.
    a. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
  8. Sealants: Latex, complying with ASTM C 834, Type P, Grade NF and with applicable requirements in Division 07 Section "Joint Sealants", recommended by sealant manufacturer and manufacturer of substrates for intended application.

K. Fabrication
  1. Back out or kerf backs of standing and running trim wider than 5 inches (125 mm), except members with ends exposed in finished work.
  2. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
  1. Clean substrates of projections and substances detrimental to application.
  2. Prime lumber to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Division 09 Section "Exterior Painting".

B. Installation, General
  1. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
    a. Do not use manufactured units with defective surfaces, sizes, or patterns.
  2. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

- a. Scribe and cut exterior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
- b. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
- c. Install stairs with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and with no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
- d. Coordinate exterior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.

C. Standing And Running Trim Installation

- 1. Install flat grain lumber with bark side exposed to weather.
- 2. Install cellular PVC trim to comply with manufacturer's written instructions.
- 3. Install trim with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long except where necessary.
  - a. Use scarf joints for end-to-end joints.
  - b. Stagger end joints in adjacent and related members.
- 4. Fit exterior joints to exclude water. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.
- 5. Unless otherwise indicated, countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.

D. Siding Installation

- 1. Install siding to comply with manufacturer's written instructions and warranty requirements.
- 2. Horizontal Lumber Siding: Apply starter strip along bottom edge of sheathing or sill. Install first course of siding with lower edge at least 1/8 inch (3 mm) below starter strip and subsequent courses lapped 1 inch (25 mm) over course below. Nail at each stud. Do not allow nails to penetrate more than one thickness of siding.
- 3. Diagonal Lumber Siding: Begin application at corner with tongue edge up. Install subsequent courses with tongue-and-groove edges tightly fitted together. Nail at each stud.
  - a. Leave 1/8-inch (3-mm) gap at trim and corners unless otherwise recommended by manufacturer, and apply sealant.
  - b. Butt joints only over framing or blocking, nailing top and bottom on each side and staggering joints in subsequent courses.
  - c. Install prefabricated outside corners as recommended by manufacturer of siding materials.
- 4. Plywood Siding: Install panels with edges over framing or blocking. Nail at 6 inches (150 mm) o.c. at panel perimeter and 12 inches (300 mm) o.c. at intermediate supports unless manufacturer recommends closer spacing. Leave 1/16-inch (1.5-mm) gap between adjacent panels and 1/8-inch (3-mm) gap at perimeter, openings, and horizontal joints unless otherwise recommended by panel manufacturer.
  - a. Seal butt joints at inside and outside corners and at trim locations.
  - b. Install continuous metal flashing at horizontal panel joints.
  - c. Apply battens and corner trim as indicated. Countersink nail heads, fill flush, and sand filler.
  - d. Conceal fasteners to greatest practical extent by countersinking and filling, by placing in grooves of siding pattern or by concealing with applied trim or battens as detailed. Do not nail through overlapping pieces.
- 5. Hardboard Siding: Install hardboard siding complying with AHA's "Recommended Basic Application and Painting Instructions for Hardboard Siding." Install panels with edges over framing or blocking. Leave 3/16-inch (5-mm) gap at perimeter, openings, and horizontal panel joints unless otherwise recommended by panel manufacturer.
  - a. Seal butt joints at inside and outside corners and at trim locations.
  - b. Install continuous metal flashing at horizontal panel joints.
  - c. Apply battens and corner trim as indicated.

   d. Conceal fasteners to greatest practical extent by placing in grooves of siding pattern or by concealing with applied trim or battens as detailed.
6. Flashing: Install metal flashing as indicated on Drawings and as recommended by siding manufacturer.
7. Finish: Apply finish within two weeks of installation.

E. Stair And Railing Installation
   1. Treads and Risers at Exterior Stairs: Secure treads and risers by gluing and nailing to carriages. Countersink nail heads, fill flush, and sand filler. Extend treads over carriages and finish with bullnose edge.
   2. Balusters: Fit balusters to treads, glue, and nail in place. Countersink nail heads, fill flush, and sand filler. Let into railings and glue in place.
   3. Newel Posts: Secure newel posts to stringers and risers with through bolts **OR** lag screws **OR** countersunk-head wood screws and glue, **as directed**.
   4. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue.

F. Ornamental Column Installation
   1. Install columns to comply with manufacturer's written instructions. Comply with requirements below unless manufacturer's written instructions state otherwise.
   2. Lay out column locations on soffits and beams and plumb down to locate column locations at supports.
   3. Set plinths in location, shim as required to temporarily level, and scribe and trim as required so that top of plinths will sit level without use of shims. Fasten plinths in place to support using pins or fasteners as recommended by manufacturer.
   4. Scribe and trim tops of columns to fit to soffits and beams. Maintain ventilation passages to interior of columns.
   5. Seal ends of columns with two coats of wood sealer or primer.
   6. Install column caps and flashing on columns and fasten to column. Install caps and flashing so that loads are not imposed on caps and so that ventilation of column interior is not blocked.
   7. Secure columns in place at top and bottom with fasteners recommended by manufacturer.

G. Adjusting
   1. Replace exterior finish carpentry that is damaged or does not comply with requirements. Exterior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

H. Cleaning
   1. Clean exterior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

I. Protection
   1. Protect installed products from damage from weather and other causes during construction.
   2. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
      a. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
      b. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 06 20 13 00

SECTION 06 20 23 00 – INTERIOR FINISH CARPENTRY

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for interior finish carpentry. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
    a. Interior standing and running trim.
    b. Fire-rated interior door and sidelight frames.
    c. Plywood, Hardboard, and Board paneling.
    d. Shelving and clothes rods.
    e. Interior stairs and railings.
    f. Interior ornamental wood columns.

C. Definitions

1. Lumber grading agencies, and the abbreviations used to reference them, include the following:
    a. NeLMA: Northeastern Lumber Manufacturers' Association.
    b. NHLA: National Hardwood Lumber Association.
    c. NLGA: National Lumber Grades Authority.
    d. SPIB: The Southern Pine Inspection Bureau.
    e. WCLIB: West Coast Lumber Inspection Bureau.
    f. WWPA: Western Wood Products Association.
2. MDF: Medium-density fiberboard.
3. MDO Plywood: Plywood with a medium-density overlay on the face.

D. Submittals

1. Product Data: For each type of process and factory-fabricated product.
2. Samples: For each type of paneling indicated.
3. LEED Submittals:
    a. Product Data for Credit EQ 4.1: For adhesives and glues used at Project site, including printed statement of VOC content.
    b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
    c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
        1) Include statement indicating costs for each certified wood product.
4. Research/Evaluation Reports: Showing that fire-retardant-treated wood complies with building code in effect for Project.
5. Warranty: Special warranty specified in this Section.

E. Quality Assurance

1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
    a. Interior standing and running trim.
    b. Interior plywood, hardboard, and board paneling.
    c. Shelving and clothes rods.
    d. Interior stairs and railings.
    e. Interior ornamental wood columns.

F. Delivery, Storage, And Handling
1. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.
2. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

G. Warranty
1. Special Warranty for Columns: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace columns that fail in materials or workmanship five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials, General
1. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
2. Softwood Plywood: DOC PS 1.
3. Hardboard: AHA A135.4.
4. MDF: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.
5. Particleboard: ANSI A208.1, Grade M-2 **OR** M-2-Exterior Glue **OR** M-2, made with binder containing no urea-formaldehyde resin, **as directed**.
6. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

B. Wood-Preservative-Treated Materials
1. Lumber: AWPA C2 **OR** AWPA C31 (treated with inorganic boron), **as directed**. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: AWPA C9. Kiln dry after treatment to a maximum moisture content of 18 percent.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
4. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
5. Do not use material that is warped or does not comply with requirements for untreated material.
6. Mark lumber with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
7. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
8. Application: Where indicated.

C. Fire-Retardant-Treated Materials
1. Lumber: Comply with performance requirements in AWPA C20, Exterior type **OR** Interior Type A, **as directed**. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: Comply with performance requirements in AWPA C27, Exterior type **OR** Interior Type A, **as directed**. Kiln dry after treatment to a maximum moisture content of 15 percent.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants and provide materials that do not have marks from spacer sticks on the exposed face.
4. Do not use material that does not comply with requirements for untreated material or is warped or discolored.

5. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
6. Application: Where indicated **OR** All interior lumber and plywood, **as directed**.

D. Standing And Running Trim
1. Softwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
   a. Species and Grade:
      1) Eastern white pine, C Select **OR** D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
      2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
      3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
      4) White woods, C Select **OR** D Select **OR** 1 Common **OR** 2 Common, **as directed**; WWPA.
      5) Douglas fir-larch or Douglas fir south, Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA.
      6) Southern pine, B & B **OR** C & Btr, **as directed**, finish; SPIB.
      7) Western red cedar, Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
   b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
   c. Finger Jointing: Allowed **OR** Not allowed, **as directed**.
   d. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
2. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
   a. Species and Grade: Red oak **OR** White maple **OR** Alder **OR** Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar, **as directed**; Clear **OR** A finish **OR** B finish, **as directed**; NHLA.
   b. Maximum Moisture Content: 13 **OR** 10 **OR** 9, **as directed**, percent.
   c. Finger Jointing: Not allowed.
   d. Gluing for Width: Allowed **OR** Not allowed **OR** Use for lumber trim wider than 6 inches (150 mm), **as directed**.
   e. Veneered Material: Allowed **OR** Not allowed **OR** Use for lumber trim wider than 6 inches (150 mm), **as directed**.
   f. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
   g. Matching: Selected for compatible grain and color.
3. Lumber Trim for Opaque Finish (Painted):
   a. Species and Grade:
      1) Eastern white pine, D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
      2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
      3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
      4) White woods, D Select **OR** 1 Common **OR** 2 Common, **as directed**; WWPA.
      5) Douglas fir-larch or Douglas fir south, Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA.
      6) Spruce-pine-fir, 1 **OR** 2, **as directed**, Common; NeLMA, NLGA, WCLIB, or WWPA.
      7) Alder, aspen, basswood, cottonwood, gum, magnolia, soft maple, sycamore, tupelo, or yellow poplar; A **OR** B, **as directed**, finish; NHLA.
   b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
   c. Finger Jointing: Allowed **OR** Not allowed, **as directed**.

   d. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
   e. Optional Material: Primed MDF of same actual dimensions as lumber indicated may be used in lieu of lumber.
4. Softwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA WM 4, N-grade wood moldings. Made to patterns included in WMMPA WM 12.
   a. Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** Southern pine **OR** Western red cedar **OR** Douglas fir, **as directed**.
   b. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
   c. Finger Jointing: Not allowed.
   d. Matching: Selected for compatible grain and color.
   e. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch **OR** WM 753, 9/16-by-3-1/4-inch (14-by-83-mm) beaded-edge **OR** WM 620, 9/16-by-4-1/4-inch (14-by-108-mm) ogee **OR** WM 750, 9/16-by-4-1/4-inch (14-by-108-mm) beaded-edge, **as directed**, base.
   f. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** WM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
   g. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge **OR** WM 376, 11/16-by-2-1/4-inch (17-by-57-mm) beaded-edge, **as directed**, casing.
   h. Mull-Casing Pattern: WM 957, 3/8-by-1-3/4-inch (9.5-by-44-mm) beaded-edge **OR** WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
   i. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
   j. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.
5. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA HWM 2, N-grade wood moldings made to patterns included in WMMPA HWM 1.
   a. Species: Red oak **OR** White maple **OR** Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar, **as directed**.
   b. Kiln-dried softwood or MDF, with exposed surfaces veneered with species indicated, may be used in lieu of solid wood.
   c. Maximum Moisture Content: 9 percent.
   d. Finger Jointing: Not allowed.
   e. Matching: Selected for compatible grain and color.
   f. Base Pattern: HWM 633, 7/16-by-3-1/4-inch (11-by-83-mm) ogee **OR** HWM 713, 7/16-by-3-1/4-inch (11-by-83-mm) ranch **OR** HWM 753, 7/16-by-3-1/4-inch (11-by-83-mm) beaded-edge **OR** WM 620, 7/16-by-4-1/4-inch (11-by-108-mm) ogee, **as directed**, base.
   g. Shoe-Mold Pattern: HWM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** HWM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** HWM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
   h. Casing Pattern: HWM 328, 1/2-by-2-1/4-inch (13-by-57-mm) clamshell **OR** HWM 366, 1/2-by-2-1/4-inch (13-by-57-mm) featheredge **OR** HWM 376, 1/2-by-2-1/4-inch (13-by-57-mm) beaded-edge, **as directed**, casing.
   i. Mull-Casing Pattern: HWM 989, 3/16-by-2-inch (5-by-51-mm) square-edge **OR** HWM 988, 3/8-by-1-1/2-inch (9.5-by-38-mm) featheredge **OR** HWM 987, 3/8-by-2-inch (9.5-by-51-mm) featheredge, **as directed**, casing.
   j. Stop Pattern: HWM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** HWM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** HWM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
   k. Chair-Rail Pattern: HWM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.
6. Moldings for Opaque Finish (Painted): Made to patterns included in WMMPA WM 12.
   a. Softwood Moldings: WMMPA WM 4, P-grade.
      1) Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine.

    2) Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
  b. Hardwood Moldings: WMMPA HWM 2, P-grade.
    1) Species: Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar.
    2) Maximum Moisture Content: 9 percent.
  c. Optional Material: Primed MDF.
  d. Finger Jointing: Allowed **OR** Not allowed, **as directed**.
  e. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch **OR** WM 753, 9/16-by-3-1/4-inch (14-by-83-mm) beaded-edge **OR** WM 620, 9/16-by-4-1/4-inch (14-by-108-mm) ogee **OR** WM 750, 9/16-by-4-1/4-inch (14-by-108-mm) beaded-edge, **as directed**, base.
  f. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** WM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
  g. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge **OR** WM 376, 11/16-by-2-1/4-inch (17-by-57-mm) beaded-edge, **as directed**, casing.
  h. Mull-Casing Pattern: WM 957, 3/8-by-1-3/4-inch (9.5-by-44-mm) beaded-edge **OR** WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
  i. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
  j. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.
7. PVC-Wrapped Moldings: WMMPA WM 2 and made to patterns included in WMMPA WM 12.
  a. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch, **as directed**, base.
  b. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round, **as directed**, shoe mold.
  c. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge, **as directed**, casing.
  d. Mull-Casing Pattern: WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
  e. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
  f. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.
  g. Colors, Textures, and Grain Patterns: As selected by The University from manufacturer's full range.
8. Foam Plastic Moldings: Molded product of shapes indicated, with a tough outer skin on exposed surfaces; factory primed. Exposed surfaces shall not be shaped after molding.
  a. Density: Not less than 20 lb/cu. ft. (320 kg/cu. m).
  b. Flame-Spread Index: Not more than 75 when tested according to ASTM E 84.
  c. Thickness: Not more than 1/2 inch (12.7 mm).
  d. Width: Not more than 8 inches (204 mm).
  e. Patterns: As indicated by manufacturer's designations.

E. Fire-Rated Interior Door And Sidelight Frames
1. Frames, complete with casings, fabricated from fire-retardant particleboard or fire-retardant MDF with veneered exposed surfaces, or from solid fire-retardant-treated wood. Frames shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, based on testing according to NFPA 252 **OR** UBC Standard 7-2, **as directed**.
  a. Species: Red oak **OR** White oak **OR** White maple **OR** Cherry, **as directed**.
  b. Fire Rating: 20 minutes **OR** 30 minutes **OR** 45 minutes **OR** 60 minutes **OR** 90 minutes **OR** As indicated, **as directed**.

F. Paneling
1. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1, made without urea-formaldehyde adhesive.
    a. Face Veneer Species and Cut: Rotary-cut white birch **OR** Plain-sliced red oak **OR** Plain-sliced hickory, **as directed**.
    b. Veneer Matching: Random match **OR** Selected for similar color and grain, **as directed**.
    c. Backing Veneer Species: Same species as face veneer **OR** Any hardwood compatible with face species, **as directed**.
    d. Construction: Veneer core.
    e. Thickness: 1/8 inch (3.2 mm) **OR** 5/32 inch (4 mm) **OR** 5 mm **OR** 1/4 inch (6.4 mm) **OR** 5/16 inch (7.9 mm) **OR** 7/16 inch (11 mm), **as directed**.
    f. Glue Bond: Type II (interior) **OR** I (exterior), **as directed**.
2. Hardboard Paneling: Interior factory-finished hardboard paneling complying with AHA 135.5.
    a. Thickness: 1/8 inch (3.2 mm) **OR** 5/32 inch (4 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
    b. Finish: Class I **OR** II, **as directed**.
    c. Surface-Burning Characteristics: As follows, tested per ASTM E 84:
        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 450 or less.
3. Board Paneling: Interior wood board paneling complying with WMMPA WM 9.
    a. Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** Southern pine **OR** Western red cedar **OR** Figured red gum, **as directed**.
    b. Grade: Clear No. 1 **OR** Clear No. 2 **OR** Knotty No. 1 **OR** Knotty No. 2 **OR** Finger jointed, **as directed**.
    c. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less **OR** 9 percent, **as directed**.
4. Board Paneling:
    a. Species and Grade:
        1) Eastern white pine, C Select **OR** D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
        2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
        3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
        4) Southern pine, B & B **OR** C & Btr **OR** No. 2, **as directed**, Paneling; SPIB.
        5) Western red cedar, Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
    b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.

G. Shelving And Clothes Rods
1. Exposed **OR** Closet **OR** Utility, **as directed**, Shelving: Made from one of the following materials, **as directed**, 3/4 inch (19 mm) thick. Do not use particleboard or MDF that contains urea formaldehyde.
    a. Particleboard with radiused and filled **OR** solid-wood, **as directed**, front edge.
    b. MDF with radiused **OR** solid-wood, **as directed**, front edge.
    c. MDO softwood plywood with solid-wood edge.
    d. Melamine-faced particleboard with radiused and filled **OR** applied PVC, **as directed**, front edge.
    e. Wood boards as specified above for lumber trim for opaque **OR** softwood lumber trim for transparent **OR** hardwood lumber trim for transparent, **as directed**, finish.
    f. Softwood Boards: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA; kiln dried.

g. Softwood Boards: Douglas fir-larch, Douglas fir south, or hem-fir; Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA; or southern pine, B & B **OR** C, **as directed**, finish; SPIB; kiln dried.

2. Shelf Cleats: 3/4-by-3-1/2-inch (19-by-89-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards with hole and notch to receive clothes rods, **as directed**, as specified above for shelving **OR** lumber trim for opaque finish **OR** softwood lumber trim for transparent finish **OR** hardwood lumber trim for transparent finish, **as directed**.
3. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.
4. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.
5. Standards for Adjustable Shelf Brackets: BHMA A156.9, B04102; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
6. Adjustable Shelf Brackets: BHMA A156.9, B04112; powder-coat finished steel **OR** brass-finished steel **OR** zinc-plated steel **OR** bronze-anodized aluminum **OR** black-anodized aluminum **OR** natural aluminum, **as directed**.
7. Standards for Adjustable Shelf Supports: BHMA A156.9, B04071; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
8. Adjustable Shelf Supports: BHMA A156.9, B04081 or B04091; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
9. Clothes Rods: 1-1/2-inch- (38-mm-) diameter, clear, kiln-dried hardwood **OR** clear, kiln-dried softwood; either Douglas fir or southern pine, **as directed**.
10. Clothes Rods: 1-5/16-inch- (33-mm-) diameter, aluminum tubes **OR** chrome-plated steel tubes **OR** chrome-plated steel telescoping tubes with end brackets for mounting on shelf cleats, **as directed**.
11. Rod Flanges: Clear, kiln-dried, Douglas fir or southern pine **OR** eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** red oak **OR** white maple **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar, **as directed**, turnings.
12. Rod Flanges: Aluminum **OR** Chrome-plated steel **OR** Stainless steel, **as directed**.

H. Stairs And Railings

1. Treads: 1-1/16-inch (27-mm), clear, kiln-dried, edge-glued, rift-sawn red oak **OR** red oak **OR** hard maple **OR** poplar, **as directed**, stepping with half-round nosing.
2. Risers: 13/16-inch (21-mm), clear, kiln-dried, edge-glued red oak **OR** hard maple **OR** poplar, **as directed**, stock.
3. Risers: 3/4-inch (19-mm) finish boards as specified above for interior lumber trim for opaque finish.
4. Finished Stringers: 3/4-inch (19-mm) finish boards as specified above for interior lumber trim for opaque finish.
5. Interior Railings: Clear, kiln-dried red oak **OR** hard maple **OR** yellow poplar, **as directed**.
6. Balusters: Clear, kiln-dried, red oak **OR** hard maple **OR** yellow poplar, **as directed**.
7. Newel Posts: Clear, kiln-dried, red oak **OR** hard maple **OR** yellow poplar, **as directed**.
8. Factory fabricate columns for transparent finish from clear, kiln-dried eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar **OR** red oak **OR** white maple **OR** mahogany, **as directed**.
9. Factory fabricate columns for opaque finish from clear, kiln-dried eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar, **as directed**. Column staves may be finger jointed.
10. Shafts: Built up from tongue-and-groove staves joined with waterproof glue. Lathe turn shafts to provide indicated base diameter and true architectural entasis taper. Precisely mill flutes as indicated.
11. Capital and Base: Molded glass-fiber-reinforced plastic **OR** Built up from wood components with waterproof glue. Turn circular elements on lathes, **as directed**.
12. Prime columns for opaque finish with one coat of interior wood primer compatible with specified topcoats.

I. Miscellaneous Materials

1. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

a. Where galvanized finish is indicated, provide fasteners and anchorages with hot-dip galvanized coating complying with ASTM A 153/A 153M.

2. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
   a. Use wood glue that has a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Installation Adhesive for Foam Plastic Moldings: Product recommended for indicated use by foam plastic molding manufacturer.
   a. Use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Paneling Adhesive: Comply with paneling manufacturer's written recommendations for adhesives.
   a. Use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.
   a. Use adhesive that has a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

J. Fabrication
1. Back out or kerf backs of the following members except those with ends exposed in finished work:
   a. Interior standing and running trim except shoe and crown molds.
   b. Wood board paneling.
2. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
1. Clean substrates of projections and substances detrimental to application.
2. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

B. Installation, General
1. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
   a. Do not use manufactured units with defective surfaces, sizes, or patterns.
2. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
   a. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
   b. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
   c. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining interior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
   d. Install stairs with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and with no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
   e. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

C. Standing And Running Trim Installation
1. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long, except where necessary.

Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.

- a. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
- b. Install trim after gypsum board joint finishing operations are completed.
- c. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

D. Paneling Installation

1. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.
    - a. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners as recommended by panel manufacturer.
    - b. Conceal fasteners to greatest practical extent.
    - c. Arrange panels with grooves and joints over supports. Fasten to supports with nails of type and at spacing recommended by panel manufacturer. Use fasteners with prefinished heads matching groove color.
2. Hardboard Paneling: Install according to manufacturer's written recommendations. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Butt adjacent panels with moderate contact. Use fasteners with prefinished heads matching paneling color.
    - a. Wood Stud or Furring Substrate: Install with 1-inch (25-mm) annular-ring shank hardboard nails.
    - b. Plaster or Gypsum Board Substrate: Install with 1-5/8-inch (41-mm) annular-ring shank hardboard nails.
    - c. Nailing: Space nails 4 inches (100 mm) o.c. at panel perimeter and 8 inches (200 mm) o.c. at intermediate supports unless otherwise required by manufacturer.
3. Board Paneling: Install according to manufacturer's written instructions. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
    - a. Install in full lengths without end joints.
      OR
      Stagger end joints in random pattern to uniformly distribute joints on each wall.
    - b. Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of paneling.
      OR
      Install with uniform end joints. Locate end joints only over furring or blocking.
    - c. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards. Install with uniform tight joints between boards.
    - d. Fasten paneling by face nailing, setting nails, and filling over nail heads.
      OR
      Fasten paneling with trim screws, set below face and filled.
      OR
      Fasten paneling by blind nailing through tongues.
      OR
      Fasten paneling with paneling system manufacturer's concealed clips.
      OR
      Fasten paneling to gypsum wallboard with panel adhesive.

E. Shelving And Clothes Rod Installation

1. Cut shelf cleats at ends of shelves about 1/2 inch (13 mm) less than width of shelves and sand exposed ends smooth.
2. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches (400 mm) o.c. Use 2 fasteners at each framing member or fastener location for cleats 4 inches nominal (89 mm actual) in width and wider.

      a. Apply a bead of multipurpose construction adhesive to back of shelf cleats right before installing. Remove adhesive that is squeezed out immediately after fastening shelf cleats in place.
   3. Install shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches (900 mm) o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
   4. Install standards for adjustable shelf supports according to manufacturer's written instructions. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Space fasteners not more than 12 inches (300 mm) o.c.
   5. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches (900 mm) o.c. and within 6 inches (150 mm) of end of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
   6. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.
      a. Fasten shelves to cleats with finish nails or trim screws, set flush.
      b. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.
   7. Install rod flanges for rods as indicated. Fasten to shelf cleats, framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Install rods in rod flanges.

F. Stair And Railing Installation
   1. Treads and Risers at Interior Stairs: Secure treads and risers by gluing and nailing to rough carriages.
      a. Closed Stringers: House treads and risers into wall stringers, glue, and wedge into place **OR** Cope wall stringers to fit tightly over treads and risers, **as directed**.
      b. Open Stringers: Miter risers and stringer at open stringers. Extend tread over open stringers and finish with bullnose edge cut from tread stock and fitted to tread with mitered return at nosing.
   2. Balusters: Dovetail or mortise balusters into treads, glue, and nail in place. Let into railings and glue in place.
   3. Newel Posts: Secure newel posts to stringers, rough carriages, and risers with countersunk-head wood screws and glue.
   4. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue. Assemble railings at goosenecks, easements, and splices with rail bolts and glue.

G. Ornamental Column Installation
   1. Install columns to comply with manufacturer's written instructions. Comply with requirements below unless manufacturer's written instructions state otherwise.
   2. Lay out column locations on ceiling and plumb down to locate column locations at floor.
   3. Set plinths in location, shim to temporarily level, and scribe and trim as required so that tops of plinths will sit level without use of shims. Seal cut surfaces with wood sealer or primer and fasten plinths to floor using pins or fasteners as recommended by manufacturer.
   4. Set columns in location, shim as required to temporarily plumb, scribe and trim as required so that columns will sit plumb without shims.
   5. Scribe and trim tops of columns to fit to ceiling.
   6. Seal ends of columns with wood sealer or primer.
   7. Install column caps on columns and fasten to columns.
   8. Secure columns in place at top and bottom with fasteners recommended by manufacturer.

H. Adjusting
   1. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

I. Cleaning

1. Clean interior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

J. Protection
  1. Protect installed products from damage from weather and other causes during remainder of the construction period.
  2. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
    a. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
    b. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

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SECTION 06 41 00 00 – ARCHITECTURAL WOOD CASE WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in successfully producing architectural woodwork similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.

1.01.1.1.3 Single Source Manufacturing and Installation Responsibility: Engage the Manufacturer to assume undivided responsibility for woodwork specified in this section, including fabrication, finishing, and installation.

B. AWI Quality Standard: Comply with applicable requirements of "Architectural Woodwork Quality Standards" published by the Architectural Woodwork Institute (AWI) except as otherwise indicated.

1.4 SUBMITTALS

A. Samples:

1. Samples for initial selection purposes of the following in form of manufacturer's color charts consisting of actual units or sections of units showing full range of colors, textures, and patterns available for each type of material indicated.

    a. Plastic laminate.

    b. Solid surfacing materials.

    c. Factory applied opaque finishes.

    1.01.1.1.3.1.1 Samples for verification purposes of the following:

    d. Lumber with or for transparent finish, 50 square inches, for each species and cut, finished on one side and one edge.

    e. Veneer leaves representative of and selected from flitches to be used for transparent finished woodwork.

    f. Wood veneer faced panel products;, with or for transparent finish, 8½ inches by 11 inches, for each species and cut with one half of exposed surface finished, with separate samples of unfaced panel product used for core.

g. Lumber and panel products with factory applied opaque finish, 8½ inches by 11 inches for panels and 50 square inches for lumber, for each finish system and color, with one half of exposed surface finished.

h. Laminate clad panel products, 8½ inches, by 11 inches for each type, color, pattern, and surface finish, with separate samples of unfaced panel product used for core.

i. Corner pieces as follows:

   1) Cabinet front frame joints between stiles and rail as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.

   2) Miter joints for standing trim.

   1.01.1.1.3.1.1.1 Exposed cabinet hardware, one unit of each type and finish.

j. Solid surfacing materials.

B. Record Documents:

1. Shop drawings showing location of each item, dimensioned plans and elevations, large scale details, attachment devices, and other components.

   a. Show elevation drawings of all millwork items. Scale of drawings shall be minimum ¾”=1’-0”

   b. Show plan section drawings at each unique condition. Scale of drawings shall be minimum 1”=1’-0”

   c. Show vertical section drawings at each unique condition. Scale of drawings shall be 3”=1’-0”

   d. Show other details full size.

   e. Indicate all field measurements and all proposed deviations from the contract documents.

   f. Graphically indicate all plastic laminate and/or painted surfaces as applicable. General notes indicating location of these finishes is not acceptable.

   g. Show all approved change orders, clarification, and addendum items related to the scope of the architectural woodwork.

   h. Show locations and size of furring, blocking, and hanging strips, including concealed blocking and reinforcing specified in other Sections.

   i. Show locations and sizes of cutouts and holes for plumbing fixtures and other items installed in architectural woodwork.

1.5 DELIVERY, STORAGE and HANDLING

A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soilage, and deterioration.

1.01.1.1.4 Do not deliver woodwork until painting, wet work, grinding, and similar operations that could damage, soil, or deteriorate woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified in "Project Conditions."

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Obtain and comply with Woodwork Manufacturer's and Installer's coordinated advice for optimum temperature and humidity conditions for woodwork during its storage and installation. Do not install woodwork until these conditions have been attained and stabilized so that woodwork is within plus or minus 1.0 percent of optimum moisture content from date of installation through remainder of construction period.

1.01.1.1.5 Field Measurements: Where woodwork is indicated to be fitted to other construction, check actual dimensions of other construction by accurate field measurements before manufacturing woodwork; show recorded measurements on final shop drawings. Coordinate manufacturing schedule with construction progress to avoid delay of Work.

1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with manufacture of woodwork without field measurements. Coordinate other construction to ensure that actual dimensions correspond to guaranteed dimensions.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 HIGH PRESSURE DECORATIVE LAMINATE MANUFACTURERS

A. The notes and schedules on the Drawings establish manufacturer and model/design required for the Project. Provide the products listed unless Owner approves products of other manufacturer specifically for this Project.

2.3 PLASTIC LAMINATE MATERIAL SCHEDULE

A. WilsonArt Products or approved equal.

2.4 WOODWORK MATERIALS

A. Provide materials that comply with requirements of the AWI woodworking standard for each type of woodwork and quality grade indicated and, where the following products are part of woodwork, with requirements of the referenced product standards, that apply to product characteristics indicated:

1. Hardboard: ANSI/AHA A11

2. High Pressure Laminate: NEMA LD 3

3. Softwood Plywood: PS 1

4. Formaldehyde Emission Levels: Comply with formaldehyde emission requirements of each voluntary standard referenced below:

    a. Hardwood Plywood: Hardwood Plywood and Veneer Association

2.5 FABRICATION, GENERAL

A. Wood Moisture Content: Comply with requirements of referenced quality standard for moisture content of lumber in relation to relative humidity conditions existing during time of fabrication and in installation areas.

1.01.1.1.6 Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

1. Corners of cabinets and edges of solid wood (lumber) members less than 1 inch in nominal thickness: 1/16 inch.

2. Edges of rails and similar members more than 1 inch in nominal thickness: 1/8 inch.

B. Complete fabrication, including assembly, finishing, and hardware application, before shipment to the Project Site to maximum extent possible. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at the Project Site, provide ample allowance for scribing, trimming, and fitting.

1.01.1.1.7 Factory cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing in diagrams to produce accurately sized and shaped openings. Smooth edges of cutouts and, where located in countertops and similar exposures, seal edges of cutouts with a water-resistant coating.

2.6 FIRE RETARDANT TREATED LUMBER

A. Where indicated, pressure impregnate lumber with fire retardant chemicals of formulation indicated to produce materials with fire performance characteristics specified.

1.01.1.1.8 Fire Retardant Chemicals: Use chemical formulations specified that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated lumber from untreated lumber.

1. Organic Resin Based Formulation: Exterior type per AWPA C20 consisting of organic resin solution, relatively insoluble in water, thermally set in wood by kiln drying that does not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated lumber from untreated lumber.

B. Fire Performance Characteristics: Provide materials identical to those tested for the following fire performance characteristics per ASTM test methods indicated by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify treated lumber with classification marking of inspecting and testing organization in the form of separable paper label or, where required by authorities having jurisdiction, of imprint on lumber surfaces that will be concealed from view after installation.

1. Surface Burning Characteristics: Not exceeding values indicated below, tested per ASTM E 84 for 30 minutes with no evidence of significant combustion.

   a. Flame Spread: 25

   b. Smoke Developed: 50

C. Discard treated lumber that does not comply with requirements of referenced woodworking standard. Do not use twisted, warped, bowed, discolored, or otherwise damaged or defective lumber.

2.7 STANDING AND RUNNING TRIM AND RAILS

A. Quality Standard: Comply with AWI Section 300

1.01.1.1.9 Backout or groove backs of flat trim members and kerf backs of other wide flat members, except for members with ends exposed in finished work.

B. Assemble casings in plant except where limitations of access to place of installation require field assembly.

1.01.1.1.10 Grade: Premium

C. Lumber Species for Transparent Finish (Interior): Red oak, rift sawn

1.01.1.1.11 Lumber Species: Match species and cut indicated for other types of transparent finished architectural woodwork located in same area of building unless otherwise indicated.
  1. Provide split species on trim that face areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.

D. Lumber Species for Opaque Finish: Eastern white pine, sugar pine.

2.8 WOOD CABINETS (CASEWORK) FOR TRANSPARENT FINISH

A. Quality Standard: Comply with AWI Section 400 and its Division 400A "Wood Cabinets."

1.01.1.1.12 Grade: Premium.
  1. Grain Matching: Run and match grain vertically for drawer fronts, doors, and fixed panels.

B. Wood Species for Semiexposed Surfaces: Match species and cut indicated for exposed surfaces.

2.9 WOOD CABINETS (CASEWORK) FOR OPAQUE FINISH

A. Overlay door with Frame reveal

1.01.1.1.13 Materials for Semi-exposed Surfaces: Match materials indicated for exposed surfaces.
2.10 LAMINATE CLAD CABINETS (PLASTIC COVERED CASEWORK)

A. Quality Standard: Comply with AWI Section 400 and its Division 400B "Laminate Clad Cabinets."

1.01.1.1.14 Type of Cabinet: High pressure decorative laminate over plywood (no particleboard) core complying with the following:
  1. Grade: Premium

B. AWI Type of Cabinet Construction: Flush overlay.

1.01.1.1.15 AWI Type of Cabinet Construction: Reveal overlay.
C. AWI Type of Cabinet Construction: As indicated.

1.01.1.1.16 Laminate Cladding: High pressure decorative laminate complying with the following requirements:
  1. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

    a. Match Owner's sample.

    b. Match color, pattern, and finish indicated by reference to laminate manufacturer's standard designations for this these characteristics.

    c. Provide selections made by Owner from laminate manufacturer's full range of WilsonArt standard colors and finishes in the following categories:

      1) Solid colors

      2) Wood grains

      3) Patterns

  2. Laminate Grade for Exposed Surfaces: Provide laminate cladding complying with the following requirements for type of surface and grade.

    a. Postformed Surfaces: PF 42 (0.042 inch nominal thickness)

1.01.1.1.16.1.1 Edges: Three millimeter thick PVC, Solid, high impact, purified, color-thru, acid resistant, PVC edging machine-applied with hot melt adhesives. Machine profile all door and drawer edges and outside corners, exposed to view when doors and drawers are closed, to a 1/8 inch radius. Color to match exterior laminate.

3. Edges: GP 50 (0.050 inch nominal thickness)
4. Edges: GP 28 (0.028 inch nominal thickness)
5. Semiexposed Surfaces: Provide surface materials indicated below:
    a. High pressure laminate, GP 28. (0.028 inch nominal thickness)

2.11 CABINET HARDWARE AND ACCESSORY MATERIALS

A. Refer to schedule at end of this section for cabinet hardware required for architectural cabinets.

2.12 ARCHITECTURAL CABINET TOPS (COUNTERTOPS)

A. Quality Standard: Comply with AWI Section 400 and its Division 400C.

1.01.1.1.17 Type of Top: High pressure decorative laminate ¾ inch particleboard

1. Grade: Premium
2. Laminate Cladding for Horizontal Surface: High pressure decorative laminate as follows:
    a. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
        1) Provide selections made by Owner from manufacturer's full range of standard colors and finishes in the following categories:
            a) Solid colors
            b) Wood grains
            c) Patterns
    b. Grade: GP 50 (0.050 inch nominal thickness)
    c. Grain Direction: Parallel to longest dimension

1.01.1.1.17.1.1 Edges: Three millimeter thick PVC, Solid, high impact, purified, color-thru, acid resistant, PVC edging machine-applied with hot melt adhesives. Machine profile all edges and outside corners exposed to view to a 1/8 inch radius. Color to match surface laminate.

3. Edge Treatment: Same as laminate cladding on horizontal surfaces.
4. Edge Treatment: Lumber edge for transparent finish matching wood species and cut on cabinet surfaces.
5. Edge Treatment: As indicated.

B. Type of Top: Premium Grade Plywood for transparent finish as follows:

1. Grade: Premium.
2. Lumber Species: As indicated.

C. Type of Top: Panel product for transparent finish (wood veneer laminated over exterior grade plywood: no particleboard) as follows:

1. Grade: Premium.
2. Veneer Species: As indicated.
3. Edge Treatment: Lumber matching wood veneer face for species and cut.
4. Edge Treatment: As indicated.

1.01.1.1.17.2 FLUSH WOOD PANELING FOR TRANSPARENT FINISH

D. Grade: Premium.

1.01.1.1.18 Veneer Species: As indicated.

E. Panel Matching Method: Match panels to one another within each separate area by the following method:

1. Blueprint matched panels and components.
2. Premanufactured sets used full width.
3. Premanufactured sets selectively reduced in width.
4. Sequence matched panel sets.

F. Fire Performance Characteristics: Provide paneling composed of panels of wood veneer density and fire retardant particleboard that are identical in construction to units tested for the following surface burning characteristics per ASTM E 84 by UL or other testing and inspecting organization acceptable to authorities having jurisdiction. Identify panels with appropriate markings of applicable testing and inspecting organization on surfaces that will be concealed from view after installation.

1. Flame Spread: 75 or less.
2. Smoke Developed: 40 or less.

1.01.1.1.18.1 INTERIOR DOORS AND DOOR FRAMES

G. Quality Standard: Comply with AWI Section 900B.

1.01.1.1.19 Grade: Premium.

H. Grade: Custom.

1.01.1.1.20 Lumber Species for Transparent Finish: Match species and cut indicated for other types of transparent finished architectural woodwork located in same areas of building unless otherwise indicated.

I. Lumber Species for Opaque Finish: Any closed grain hardwood listed in referenced woodworking standard.

1.01.1.1.21 Fire Rated Doors and Frames: Provide fire rated wood frames for wood doors that are identical to units tested in door and frame assemblies per ASTM E152 and that are labeled and listed for ratings indicated by UL, Warnock Hersey, or other testing and inspection organization acceptable to authorities having jurisdiction.

2.13 FASTENERS AND ANCHORS

A. Screws: Select material, type, size, and finish required for each use. Comply with FS FF S 111 for applicable requirements.

1. For metal framing supports, provide screws as recommended by metal framing manufacturer.

B. Nails: Provide the following of type and size required for each use. Comply with FS FF N 105 for applicable requirements.

1. Stainless steel nails.

2. Aluminum nails.

3. Hot dipped galvanized nails.

4. Any material indicated above.

C. Anchors: Select material, type, size, and finish required by each substrate for secure anchorage. Provide nonferrous metal or hot dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts and anchors, as required, to be set into concrete or masonry work for subsequent woodwork anchorage.

2.14 FACTORY FINISHING OF INTERIOR ARCHITECTURAL WOODWORK

A. Quality Standard: Comply with AWI Section 1500 unless otherwise indicated.

1.01.1.1.22 The entire finish of interior architectural woodwork is specified in this section, regardless of whether factory applied or applied after installation.

1. Factory Finishing: To the greatest extent possible, finish architectural woodwork at factory. Defer only final touch up, cleaning, and polishing until after installation.

B. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces and similar preparations for finishing of architectural woodwork, as applicable to each unit of work.

1.01.1.1.23 Washcoat for Stained Finish: Apply a vinyl washcoat to woodwork made from closed-grain wood before staining and finishing.

C. Filled Finish for open-Grain Woods: After staining (if any) apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.

1.01.1.1.24 Transparent Finish: Comply with requirements indicated below for grade, finish system, staining, effect, and sheen, with sheen measured on 60 degrees gloss meter per ASTM D 523.

1. Grade: Premium.

2. Staining: Match approved sample for color.

3. Sheen: Medium gloss rubbed effect 35 45 degrees.

1.01.1.1.24.1 FACTORY FINISHING OF INTERIOR ARCHITECTURAL WOODWORK

D. Quality Standard: Comply with AWI Section 1500 unless otherwise indicated.

1.01.1.1.25 The entire finish of interior architectural woodwork is specified in this section, regardless of whether factory applied or applied after installation.

1. Factory Finishing: To the greatest extent possible, finish architectural woodwork at factory. Defer only final touch up, cleaning, and polishing until after installation.

E. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces and similar preparations for finishing of architectural woodwork, as applicable to each unit of work.

1.01.1.1.26 Washcoat for Stained Finish: Apply a vinyl washcoat to woodwork made from closed-grain wood before staining and finishing.

F. Filled Finish for open-Grain Woods: After staining (if any) apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.

1.01.1.1.27 Transparent Finish: Comply with requirements indicated below for grade, finish system, staining, effect, and sheen, with sheen measured on 60 degrees gloss meter per ASTM D 523.

1. Grade: Premium.

2. AWI Finish System #TR-5: Catalyzed vinyl lacquer.

3. Staining: Match approved sample for color.

4. Sheen: Medium gloss rubbed effect 35 45 degrees.

1.01.1.1.27.1 FACTORY FINISHING OF INTERIOR ARCHITECTURAL WOODWORK

G. Quality Standard: Comply with AWI Section 1500 unless otherwise indicated.

1.01.1.1.28 The entire finish of interior architectural woodwork is specified in this section, regardless of whether factory applied or applied after installation.

1. Factory Finishing: To the greatest extent possible, finish architectural woodwork at factory. Defer only final touch up, cleaning, and polishing until after installation.

H. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces and similar preparations for finishing of architectural woodwork, as applicable to each unit of work.

1.01.1.1.29 Washcoat for Stained Finish: Apply a vinyl washcoat to woodwork made from closed-grain wood before staining and finishing.

I. Open Finish for open-Grain Woods: Do not apply filler to open-grain woods.

1.01.1.1.30 Filled Finish for open-Grain Woods: After staining (if any) apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.

J. Transparent Finish: Comply with requirements indicated below for grade, finish system, staining, effect, and sheen, with sheen measured on 60 degrees gloss meter per ASTM D 523.

1. Grade: Premium.

2. Grade: Custom.

3. AWI Finish System #TR-7: Clear polyester.

4. Staining: None required.

5. Staining: Match approved sample for color.

6. Staining: Match Owner's sample.

7. Sheen: Medium gloss rubbed effect 35 45 degrees.

8. Sheen: Semigloss bright rubbed effect 55 60 degrees.

K. Opaque Finish: Comply with requirements indicated below for grade, finish system, color, effect, and sheen:

1. Grade: Premium.

2. Grade: Custom.

3. AWI Finish System #OP-1: Standard lacquer.

4. AWI Finish System #OP-2: Catalyzed lacquer.
5. AWI Finish System #OP-3: Water-Reducible acrylic lacquer.
6. AWI Finish System #OP-4: Conversion varnish.
7. AWI Finish System #OP-5: Catalyzed vinyl lacquer.
8. AWI Finish System #OP-6: Catalyzed polyurethane.
9. AWI Finish System #OP-7: Polyester pigmented.
10. AWI Finish System #OP-8: Polyester polyurethane pigmented.
11. Color: Match Owner's sample.
12. Color: Match color indicated by reference to a coating manufacturer's standard designations for this characteristic.
13. Color: Provide selections made by Owner from full range of standard colors available in finish system specified.
14. Sheen: Dull satin 15 20 degrees.
15. Sheen: Medium gloss rubbed effect 35 45 degrees.
16. Sheen: Semigloss bright rubbed effect 55 60 degrees.
17. Sheen: Full gloss 85 100 degrees.

PART 3 - EXECUTION

3.1 PREPARATION

A. Condition woodwork to average prevailing humidity conditions in installation areas before installing.

1.01.1.1.31 Deliver concrete inserts and similar anchoring devices to be built into substrates well in advance of time substrates are to be built.

B. Before installing architectural woodwork, examine shop fabricated work for completion and complete work as required, including back priming and removal of packing.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.32 All installation shall be in accordance with manufacturer’s published recommendations.

B. Quality Standard: Install woodwork to comply with AWI Section 1700 for same grade specified in Part 2 of this section for type of woodwork involved.

1.01.1.1.33 Install woodwork plumb, level, true, and straight with no distortions. Shim as required with concealed shims. Install to a tolerance of 1/8 inch in 8' 0" for plumb and level (including tops) and with no variations in flushness of adjoining surfaces.

C. Scribe and cut woodwork to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.

1.01.1.1.34 Fire Retardant Treated Wood: Handle, store, and install fire retardant treated wood to comply with recommendations of chemical treatment manufacturer including those for adhesives where are used to install woodwork.

D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork and matching final finish where transparent finish is indicated.

1.01.1.1.35 Standing and Running Trim and Rails: Install with minimum number of joints possible, using full length pieces (from maximum length of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns and miter at corners.

E. Cabinets: Install without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated. Maintain veneer sequence matching (if any) of cabinets with transparent finish.

1.01.1.1.36 Tops: Anchor securely to base units and other support systems as indicated.

F. Paneling: Anchor paneling to supporting substrate with concealed panel hanger clips and by blind nailing on backup strips, splined connection strips, and similar associated trim and framing. Do not face nail unless otherwise indicated.

1.01.1.1.37 Complete the finishing work specified in this section to whatever extent not completed at shop or before installation of woodwork.

3.3 ADJUSTMENT AND CLEANING

A. Repair damaged and defective woodwork where possible to eliminate defects functionally and visually; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

1.01.1.1.38 Clean, lubricate, and adjust hardware.

B. Clean woodwork on exposed and semi-exposed surfaces. Touch up factory applied finishes to restore damaged or soiled areas.

3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, which ensures that woodwork is being without damage or deterioration at time of Substantial Completion.

3.5 HARDWARE SCHEDULE

A. Provide the following items of cabinet hardware at locations indicated and required for proper operation of doors, drawers, and accessories.

1. Hinges:

    a. Blum 120 Full Overlay

    1.01.1.1.38.1.1 Drawer/Door Pulls:

    b. Ives PA-28 3 inch on center

    1.01.1.1.38.1.2 Door Catches: Stanley No. SP41, US 28 at single doors, provide two at doors over 48 inches high. Stanley No. SP45, US 28 at double doors or KV918 heavy duty catch.

2. Drawer Slides: Full extension type, KV-8400D, provide one pair at each drawer.

3. Pilaster Shelf Standards: KV 255NP, recessed.

4. Adjustable Shelf Supports:

    a. Type 1 - KV 256 NP.

   b. Type 2 – B 45 NP.

   1.01.1.1.38.1.3 End Sockets for Closet Rod: KV 734 and KV 735.

5. Closet Rods: KV 660.
6. Cabinet Cylinder-locks: Best Lock Corporation, 5L Series (verify keying with Owner).
7. Glass Door Slides.
8. Standard wall bracket shelving (S.W.B.S.): KV-51NP Standards with KV-52NP supports.
9. Keyboard Drawer Slides: KV 8100
10. Recessed Cabinet (flipper) Door Hardware: KV 8080

END OF SECTION 06 41 00 00

SECTION 07 21 00 00 – THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 definitions

A. Thermal Resistivity: Where the thermal resistivity of insulation products is designated by "r values," they represent the reciprocal of thermal conductivity (k values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

1.4 QUALITY ASSURANCE

A. Fire Performance Characteristics: Provide insulation materials identical to those whose indicated fire performance characteristics have been determined per the ASTM test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing and inspecting organization.

1. Surface Burning Characteristic: ASTM E 84

2. Fire Resistance Ratings: ASTM E 119

B. Single Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.5 SUBMITTALS

A. Product Data:

1. Submit a complete listing of all manufacturers, products, model numbers, and designs proposed for use in the Work of this Section.

2. Include code compliance verification, R-values, moisture permeability, fire ratings and installation instructions.

B. Record Documents:

1. Maintain two copies of all shop drawings, product data, and samples, manufacturer's specifications, recommendations, installation instructions, and maintenance data at the Project Site.

2. At Project Closeout, turn over both copies to the Architect who will transmit one copy to UT Health.

1.01.1.1.2.1 DELIVERY, STORAGE and HANDLING

C. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location.

1.01.1.1.3 Comply with manufacturer's recommendations for handling, storage, and protection during installation.

D. Protect plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver plastic insulating materials to the Project Site ahead of installation time.
3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 INSULATING MATERIALS

A. Provide insulating materials that comply with requirements and with referenced standards.

1. Preformed Units: Sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.

B. Extruded Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation with closed cells and integral high density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578 for type indicated; with 5 year aged r values of 5.4 and 5 at 40 and 75 degrees F (4.4 and 23.9 degrees C), respectively; and as follows:

1. Type IV, 1.6 pcf min. density, unless otherwise indicated.
2. Type V, 3.0 pcf min. density where indicated.
3. Type VI, 1.8 pcf min. density.
4. Type VII, 2.2 pcf min. density.
5. Type X, 1.35 pcf min. density.
6. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 75 and 450, respectively.
7. Manufacturers:
    a. Tenneco Building Products Co.
    b. DiversiFoam Products.
    c. Dow: The Dow Chemical Company.

    d. UC Industries, Inc.

C. Fabric Faced Extruded Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation with closed cells and integral high density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578 for type indicated; fabricated with tongue and groove edges and with one side having a matrix of vertical and horizontal drainage channels faced with manufacturer's standard spunbonded filtration fabric; with 5 year aged r value of 4.4 at 75 degrees F (23.9 degrees C).

1. Dow "Styrofoam Thermadry".
2. Type IV, 1.6 pcf min. density.
3. Type VI, 1.8 pcf min. density.
4. Type VII, 2.2 pcf min. density.

D. Molded Polystyrene Board Insulation: Rigid, cellular thermal insulation formed by the expansion of polystyrene resin beads or granules in a closed mold to comply with ASTM C 578 for type indicated; and as follows:

1. Type I, 0.9 pcf min. density, aged r values of 4.0 and 3.6 at 40 and 75 degrees F (4.4 and 23.9 degrees C), respectively.
2. Type II, 1.35 pcf min. density, aged r values of 4.4 and 4.0 at 40 and 75 degrees F (4.4 and 23.9 degrees C), respectively.
3. Type VIII, 1.15 pcf min. density, aged r values of 4.2 and 3.8 at 40 and 75 degrees F (4.4 and 23.9 degrees C), respectively.
4. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 75 and 450, respectively.
5. Manufacturers:
    a. AFM Corporation.
    b. DiversiFoam Products.
    c. Grace Construction Products Div., W.R. Grace & Co.
    d. Manufacturers with a third party certification program satisfying mandatory requirements for foam plastics of model building codes.

E. Polyisocyanurate Board Insulation: Rigid, cellular thermal insulation with glass fiber reinforced polyisocyanurate closed cell foam core and aluminum foil facing laminated to both sides; complying with FS HH I 1972/1, Class 2; aged r values of 8 and 7.2 at 40 and 75 degrees F (4.4 and 23.9 degrees C), respectively; and as follows:

1. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 75 and 450, respectively.
2. Celotex "Thermax".

F. Cellular Glass Block Insulation: Rigid cellular glass thermal insulation with closed cell structure, passing ASTM E 136 for testing of combustion characteristics, in flat or tapered block form complying with ASTM C 552 for Type I; with r values of 3.03 and 2.86 at 50 and 75 degrees F (10 and 23.9 degrees C), respectively.

1. Pittsburgh Corning Corporation "FOAMGLAS".

G. Unfaced, Flexible Glass Fiber Board Insulation: Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C 553, Class B 4, and ASTM C 612, Class 1; with nominal density of not less than 1.5 nor more than 1.65 pcf, r value of 4.13 at 75 degrees F (23.9 degrees C), and maximum flame spread and smoke developed values of 25 and 50, respectively.

1. Products:
    a. CertainTeed "WP 165".
    b. Knauf "IB 1.6".
    c. Schuller "Insul-Shield 150"
    d. Owens Corning "701".

H. Foil Faced, Flexible Glass Fiber Board Insulation: Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C 553, Class B 4, and ASTM C 612, Class 1; with nominal density of 1.5 pcf and r value of 4.13 at 75 degrees F (23.9 degrees C); foil scrim kraft vapor retarder facing on one side with maximum flame spread and smoke developed values of 25 and 50, respectively.

1. Products:
    a. CertainTeed "WP 165".
    b. Knauf "IB 2.25".
    c. Schuller "Insul-Shield 150"
    d. Owens Corning "703".

I. Unfaced Glass Fiber Board Insulation: Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C 612 for Class indicated; and as follows:

1. Low Density Semi Rigid Board: Class 1, nominal density of 2.25 pcf, r value of 4.3 at 75 degrees F (23.9 degrees C).
2. Medium Density Semi Rigid Board: Class 1 and 2, nominal density of 3.0 pcf, r value of 4.3 at 75 degrees F (23.9 degrees C).
3. Rigid Board: Class 1 and 2, nominal density of 6.0 pcf, r value of 4.3 at 75 degrees F (23.9 degrees C).
    a. CertainTeed "WP 225".
    b. Knauf "IB 2.25".
    c. Schuller "Insul-Shield 225"
    d. Owens Corning "225".

J. Foil Faced Glass Fiber Board Insulation: Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C 612 for Class indicated; foil scrim kraft or foil scrim polyethylene vapor retarder facing on one side with maximum flame spread and smoke developed values of 25 and 50, respectively; and as follows:

1. Low Density Semi Rigid Board: Class 1, nominal density of 2.25 pcf, r value of 4.3 at 75 degrees F (23.9 degrees C).

2. Medium Density Semi Rigid Board: Class 1 and 2, nominal density of 3.0 pcf, r value of 4.3 at 75 degrees F (23.9 degrees C).

3. Rigid Board: Class 1 and 2, nominal density of 6.0 pcf, r value of 4.3 at 75 degrees F (23.9 degrees C).

4. Products:

   a. Knauf <"IB 3.0"><"IB 4.5"><"IB 6.0">.

   b. Schuller "Insul-Shield <"300"><"600">.

   c. Owens Corning <"703"><"705">.

K. Glass Mat Faced Glass Fiber Board Insulation: Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C 612 for Class indicated; black glass fiber mat facing on one side with maximum flame spread and smoke developed values of 25 and 50, respectively; and as follows:

1. Low Density Semi Rigid Board: Class 1, nominal density of 2.25 pcf, r value of 4.3 at 75 degrees F (23.9 degrees C).

2. Medium Density Semi Rigid Board: Class 1 and 2, nominal density of 3.0 pcf, r value of 4.3 at 75 degrees F (23.9 degrees C).

3. Rigid Board: Class 1 and 2, nominal density of 6.0 pcf, r value of 4.55 at 75 degrees F (23.9 degrees C).

4. Schuller "Insul-Shield Black <"225"><"300"><"600">.

L. Unfaced Semi Refractory Fiber Board Insulation: Thermal insulation produced by combining semi refractory mineral fibers manufactured from slag with thermosetting resin binders to comply with ASTM C 612 for class indicated; passing ASTM E 136 for combustion characteristics; and as follows:

1. Low Density Semi Rigid Board: Class 1 and 2, nominal density of 4.0 pcf, r value of 4.0 at 75 degrees F (23.9 degrees C).

2. Medium Density Semi Rigid Board: Class 3, nominal density of 6.0 pcf, r value of 4.16 at 75 degrees F (23.9 degrees C).

3. Rigid Board: Class 4, nominal density of 8.0 pcf, r value of 4.35 at 75 degrees F (23.9 degrees C).

4. Fiber Color: Regular color, unless otherwise indicated.

5. Fiber Color: Darkened, where indicated.

6. Products:

   a. Cafco "Omni-Board <"3.0"><"4.5"><"6.0">.

   b. Fibrex "FBX <"CW40"><"CW70"><"CW90">.

   c. USG "Thermafiber <"CW40"><"CW70"><"CW90">.

M. Foil Faced Semi Refractory Fiber Board Insulation: Thermal insulation produced by combining semi refractory mineral fibers manufactured from slag with thermosetting resin binders to comply with ASTM C 612 for Class indicated; passing ASTM E 136 for combustion characteristics of unfaced board; foil scrim kraft or foil scrim polyethylene vapor retarder facing on one side with maximum flame spread and smoke developed values of 25 and 10, respectively; and as follows:

  1. Low Density Semi Rigid Board: Class 1 and 2, nominal density of 4.0 pcf, r value of 4.0 at 75 degrees F (23.9 degrees C).

  2. Medium Density Semi Rigid Board: Class 3, nominal density of 6.0 pcf, r value of 4.16 at 75 degrees F (23.9 degrees C).

  3. Rigid Board: Class 4, nominal density of 8.0 pcf, r value of 4.35 at 75 degrees F (23.9 degrees C).

  4. Products:

     a. Fibrex "FBX <"CW40"><"CW70"><"CW90">.

     b. USG "Thermafiber <"CW40"><"CW70"><"CW90">.

N. Glass Mat Faced Semi Refractory Fiber Board Insulation: Thermal insulation produced by combining semi refractory mineral fibers manufactured from slag with thermosetting resin binders to comply with ASTM C 612 for Class indicated; passing ASTM E 136 for combustion characteristics of unfaced board; faced on one side with black glass fiber mat; with maximum flame spread and smoke developed values of 10 and 5, respectively; and as follows:

  1. Low Density Semi Rigid Board: Class 1 and 2, nominal density of 4.0 pcf, r value of 4.0 at 75 degrees F (23.9 degrees C).

  2. Medium Density Semi Rigid Board: Class 3, nominal density of 6.0 pcf, r value of 4.16 at 75 degrees F (23.9 degrees C).

  3. Rigid Board: Class 4, nominal density of 8.0 pcf, r value of 4.35 at 75 degrees F (23.9 degrees C).

  4. Fiber Color: Darkened.

  5. Products:

     a. Fibrex "FBX <"CW40"><"CW70"><"CW90">.

     b. USG "Thermafiber <"CW40"><"CW70"><"CW90">.

O. Unfaced Mineral Fiber Blanket/Batt Insulation: Thermal insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing); and as follows:

  1. Mineral Fiber Type: Fibers manufactured from glass or slag.

  2. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 25 and 50, respectively.

  3. Products:

     a. CertainTeed "Building Insulation".

     b. Knauf "Light Density".

     c. Schuller "C.I. Unfaced".

d. Owens Corning "Fire-Core 60 S.A. Batts".

P. Faced Mineral Fiber Blanket/Batt Insulation: Thermal insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type III, Class A (blankets with reflective vapor retarder membrane facing with flame spread of 25 or less); foil scrim kraft or foil scrim polyethylene vapor retarder membrane on one face, and as follows:

1. Mineral Fiber Type: Fibers manufactured from glass or slag.

2. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 25 and 50, respectively.

3. Flanged Units: Provide blankets/batts fabricated with facing incorporating 4 inch wide flanges along their edges for attachment to framing members.

4. Products:

a. CertainTeed "Building Insulation".

b. Knauf "FSK-25".

c. Schuller "Panel Deck Insulation FSK-25".

d. Owens Corning "FS-25".

Q. Perlite Loose Fill Insulation: Expanded perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or IV (surface treated for water repellency and limited moisture absorption), r values of 3.3, 2.8 for densities of 4.1, 7.4 pcf at 75 degrees F (23.9 degrees C).

1.01.1.1.4 Glass Fiber Loose Fill Insulation: Glass fibers processed to comply with ASTM C 764 for Type (method of application) indicated below; maximum flame spread and smoke developed values of 5 and 5, respectively, and as follows:

1. Type 1 for pneumatic application.

2. Type 2 for poured application.

1.01.1.1.4.1 SAFING INSULATION AND ACCESSORIES

R. Semi Refractory Fiber Board Safing Insulation: Semi rigid boards designed for use as a fire stop at openings between edge of slab and exterior wall panels, produced by combining semi refractory mineral fiber manufactured from slag with thermosetting resin binders to comply with ASTM C 612, Class 1 and 2; nominal density of 4.0 pcf; passing ASTM E 136 for combustion characteristics; r value of 4.0 at 75 degrees F (23.9 degrees C).

1. Fibrex Inc., "FBX Safing Insulation".

2. USG "Thermafiber Safing Insulation".

S. Caulking Compound: Material approved by manufacturer of safing insulation for sealing joint between foil backing of safing insulation and edge of concrete floor slab against penetration of smoke.

1.01.1.1.5 Safing Clips: Galvanized steel safing clips approved by manufacturer of safing insulation for holding safing insulation in place.

2.3 RADIANT BARRIERS

A. Radiant Barrier Coating: Silver colored, not thickness dependent, low emissivity coating, formulated for adherence to substrates indicated.

1.01.1.1.6 Foil Kraft Laminate: Two layers of 0.0035 inch thick aluminum foil laminated to an inner layer of 100 pound basic weight kraft paper, with maximum flame spread and smoke developed ratings of 20 and 10, respectively, in sheets of the following width covering 500 sq. ft.:

1. Sheet Width: 24 inches.

2. Sheet Width: 48 inches.

B. Foil Scrim Polyethylene Laminate: Two layers of aluminum foil laminated with scrim reinforcing on polyethylene with an overall thickness of 7.5 mils, with maximum flame spread and smoke developed ratings of 5 and 10, in sheets 48 inches wide up to 375 feet long.

1.01.1.1.7 Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

1. Radiant Barrier Coating:

   a. "LO/MIT 1," Solar Energy Corp.

   1.01.1.1.7.1.1 Foil Kraft Laminate:

   b. "RX 2 Reflective Aluminum Foil Insulation," R Fax Technologies, Inc.

   1.01.1.1.7.1.2 Foil Scrim Polyethylene Laminate:

   c. "Foil Ray DS Radiant Barrier," Energy Savers Imports, Inc.

2.4 VAPOR RETARDERS

A. Reinforced Polyethylene Vapor Retarder: Multiple layers of polyethylene film reinforced with inner layers of nylon cord reinforcing and laminated together with a rubber adhesive to produce the following product in roll form:

1. Number of Layers: Two outer layers of polyethylene film and one inner layer of nylon reinforcing, with an overall thickness of 6.0 to 8.0 mils.

2. Number of Layers: Three layers of polyethylene film and two layers of nylon cord reinforcing, with an overall thickness of 10.0 to 12.0 mils.

B. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either a nonwoven grid of nylon cord of polyester scrim and weighing not less than 26 lb/1000 sq. ft. (13 kg/100 sq.m), with maximum permeance rating of 0.0403 perm (2.3 ng/PA x s x sq. m) and flame-spread and smoke-developed indicates of not more than 5 and 75, respectively.

1.01.1.1.8 Foil Polyester Film Vapor Retarder: Two layers of 0.5 mil thick polyester film laminated to an inner layer of 1.0 mil thick aluminum foil, with maximum flame spread and smoke developed ratings of 15 and 5, respectively.

C. Tape for Vapor Retarder: Pressure sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

1.01.1.1.9 Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

1. Reinforced Polyethylene Vapor Retarder:

   a. "Griffolyn T 65," Griffolyn Div., Reef Industries, Inc.

   b. "Griffolyn T 85," Griffolyn Div., Reef Industries, Inc.

   1.01.1.1.9.1.1 Fire-Retardant, Reinforced-Polyethylene Vapor Retarders:

   c. DURA-SKRIM 2FR; Raven Industries, Inc.

d. Griffolyn T-55 FR; Reef Industries, Inc. Griffolyn Div.

1.01.1.1.9.1.2 Foil Polyester Film Vapor Retarder:
e. "Alumiseal Zero Perm," Alumiseal Corp.

2.5 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation or mechanical anchors securely to substrates indicated without damaging or corroding either insulation, anchors, or substrates.

1.01.1.1.10 Adhesively Attached Pin Anchors: Perforated plate, 2 inches square, welded to projecting pin, with self locking washer, complying with the following requirements:

1. Plate: Zinc plated steel, 0.106 inch thick.

2. Pin: Copper coated low carbon steel, fully annealed, 0.106 inches in diameter, length to suit depth of insulation indicated and, with washer in place, to hold insulation tightly to substrate behind insulation.

3. Self Locking Washer: Mild steel, 0.016 inch thick, size as required to hold insulation securely.

   a. Where spindles will be exposed to human contact after installation, protect ends with capped self locking washers.

B. Asphalt Coating for Cellular Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by cellular glass block insulation manufacturer.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

   a. "PITTCOTE 300 Coating," Pittsburgh Corning Corp.

   b. "Karnak 100," Karnak Corp.

C. Protection Board: Premolded, semi rigid asphalt/fiber composition board, 1/4 inch thick, formed under heat and pressure, standard sizes.

1.01.1.1.11 Eave Ventilation Troughs: Preformed rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine substrates and conditions with Installer present, for compliance with requirements of the Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.

1.01.1.1.12 Clean substrates of substances harmful to insulations or vapor retarders, including removal of projections that might puncture vapor retarders.

B. Close off openings in cavities receiving poured in place insulation to prevent the escape of insulation. Provide bronze or stainless steel screen (inside) where openings must be maintained for drainage or ventilation.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.13 All installation shall be in accordance with manufacturer’s published recommendations.

3.3 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrate by method indicated, complying with manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

   1. Where insulation units are not held tightly in place by adjacent materials on all sides, provide wire ties or other acceptable mechanical means to prevent displacement or sagging of insulation.

B. Extend insulation full thickness as indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections that interfere with placement.

1.01.1.1.14 Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

C. Seal joints between closed cell (nonbreathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

1.01.1.1.15 Set vapor retarder faced units with vapor retarder to warm side of construction, except as otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.

   1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Set reflective, foil faced units accurately with not less than 0.75 inch air space in front of foil as indicated.

1.01.1.1.16 Place glass fiber loose fill insulation into spaces and onto surfaces as shown, either by pouring or by machine blowing. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not excessively compact.

E. Stuff glass fiber loose fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume (to a density of approximately 2.5 pcf).

3.4 INSTALLATION OF PERIMETER AND UNDER SLAB INSULATION

A. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of insulation.

1.01.1.1.17 Protect below grade insulation on vertical surfaces (from damage during back filling) by application of protection board. Set in adhesive in accordance with recommendations of manufacturer of insulation.

B. Protect top surface of horizontal insulation (from damage during concrete work) by application of protection board.

3.5 INSTALLATION OF CAVITY WALL AND MASONRY CELL INSULATION

A. On units of plastic insulation, install small pads of adhesive spaced approximately 1' 0" on center both ways on inside face, as recommended by manufacturer. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

   1. Supplement adhesive attachment of insulation by securing boards with two piece wall ties designed for this purpose and specified under Division 04 "Unit Masonry."

B. On units of cellular glass insulation, apply insulation with closely fitting joints using method indicated below:

1. Gob Method: Install four gobs of adhesive per unit and apply firmly against inside wythe of masonry or other construction as shown. Apply gobs at each corner; spread gobs to form pads 4 inches in diameter by 1/4 inch thick.

2. Serrated Trowel Method: Apply adhesive to entire surface of each cellular glass insulation unit with a serrated trowel complying with insulation manufacturer's specifications.

3. Coat edges of insulation units with a full bed of adhesive to seal joints between insulation and between insulation and adjoining construction.

4. Coat exterior face (cold face) of installed cellular glass block insulation course with asphalt coating recommended by insulation manufacturer for this purpose.

C. Pour granular insulation into cavities indicated to receive insulation, taking care to fill void spaces completely. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close ports after confirming complete coverage. Limit fall of insulation to one story in height, but not to exceed 20 feet.

3.6 INSTALLATION OF SAFING INSULATION

A. Install safing insulation to fill gap between edge of concrete floor slab and back of exterior spandrel panels on safing clips spaced as needed to support insulation but not further apart then 24 inches on center.

1.01.1.1.18 Cut safing insulation wider than gap to be filled to ensure compression fit and seal joint between insulation and edge of slab with caulking approved by safing insulation manufacturer for this purpose. Leave no voids in completed installation.

3.7 INSTALLATION OF RADIANT BARRIERS

A. Install radiant barriers in locations indicated to comply with radiant barrier insulation manufacturer's recommendations.

3.8 INSTALLATION OF VAPOR RETARDERS

A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose fiber insulation.

1.01.1.1.19 Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners 16 inches on center.

B. Seal overlapping joints in vapor retarders with adhesives or tape per vapor retarder manufacturer's printed directions. Seal butt joints and fastener penetrations with tape of type recommended by vapor retarder manufacturer. Locate all joints over framing members or other solid substrates.

1.01.1.1.20 Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor retarder manufacturer.

C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with tape of type recommended by vapor retarder manufacturer to create an airtight seal between penetrating objects and vapor retarder.

1.01.1.1.21 Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with tape or another layer of vapor retarder.

3.9 PROTECTION

A. General:

1. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes.

2. Provide temporary coverings or enclosures where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00 00

SECTION 07 71 00 00 – ROOF SPECIALITIES

1.1 GENERAL

A. Description Of Work:
  1. This specification covers the furnishing and installation of materials for manufactured roof specialties. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. Section Includes:
    a. Copings.
    b. Roof-edge flashings.
    c. Roof-edge drainage systems.
    d. Reglets and counterflashings.

C. Performance Requirements
  1. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
  2. FM Approvals' Listing (if Project is FM Global insured or if FM Approvals' requirements set a minimum quality standard): Manufacture and install copings and roof-edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-60 **OR** Class 1-75 **OR** Class 1-90 **OR** Class 1-105 **OR** Class 1-120, **as directed**. Identify materials with FM Approvals' markings.
  3. SPRI Wind Design Standard (if Project is governed by the IBC or if SPRI ES-1 sets a minimum quality standard): Manufacture and install copings and roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
    a. Design Pressure: As indicated on Drawings **OR** As directed.
  4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Submittals
  1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  2. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:
    a. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
    b. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
    c. Details of termination points and assemblies, including fixed points.
    d. Details of special conditions.
  3. Samples: For copings **OR** roof-edge flashings **OR** roof-edge drainage systems **OR** reglets and counterflashings, **as directed**, made from 12-inch (300-mm) lengths of full-size components including fasteners, cover joints, accessories, and attachments.
  4. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for copings and roof-edge flashings.
  5. Maintenance Data: For roofing specialties to include in maintenance manuals.

6. Warranty: Sample of special warranty.

E. Quality Assurance
  1. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
  1. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
  2. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

G. Warranty
  1. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
    a. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      1) Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      2) Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.
    b. Finish Warranty Period: 20 **OR** 10, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Exposed Metals
  1. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 or H01 temper.
    a. Non-Patinated Exposed Finish: Mill.
    b. Pre-Patinated Copper-Sheet Finish: Pre-patinated according to ASTM B 882.
  2. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
    a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
    b. Mill Finish: As manufactured.
    c. Exposed Coil-Coated Finishes: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Two-Coat Fluoropolymer: AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
      2) Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
      3) Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
    d. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
    e. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
  3. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:
    a. Exposed High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Two-Coat Fluoropolymer: AAMA 2604 **OR** AAMA 2605, **as directed**. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
      2) Three-Coat Fluoropolymer: AAMA 2605. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

- b. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
- c. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

4. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
5. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
   - a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   - b. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
   - c. Exposed Coil-Coated Finishes: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
     - 1) Two-Coat Fluoropolymer: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
     - 2) Three-Coat Fluoropolymer: AAMA 621. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

B. Concealed Metals
1. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
3. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
4. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.

C. Underlayment Materials
1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   - a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
   - b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
3. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

D. Miscellaneous Materials
1. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
2. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
   - a. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
   - b. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
   - c. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
   - d. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
   - e. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** silicone, **as directed**, polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
4. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
5. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
6. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

7. Solder for Copper: ASTM B 32, lead-free solder **OR** Grade Sn50, 50 percent tin and 50 percent lead, **as directed**.

E. Copings

1. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.
    - a. Coping-Cap Material: Copper, 20 oz./sq. ft. (0.68 mm thick) **OR** weight (thickness) as required to meet performance requirements, **as directed**.
        - 1) Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

      OR

      Coping-Cap Material: Formed **OR** Extruded, **as directed**, aluminum, 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** 0.080 inch (2.03 mm) thick **OR** 0.125 inch (3.18 mm) thick **OR** thickness as required to meet performance requirements, **as directed**.
        - 1) Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
        - 2) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

      OR

      Coping-Cap Material: Zinc-coated steel, nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.
        - 1) Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
        - 2) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
    - b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
    - c. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose face leg **OR** Two-way sloped coping cap, **as directed**.
    - d. Coping-Cap Attachment Method: Snap-on **OR** Face leg hooked to continuous cleat with back leg fastener exposed, **as directed**, fabricated from coping-cap material.
    - e. Snap-on-Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.

      OR

      Face Leg Cleats: Concealed, continuous galvanized-steel sheet **OR** stainless steel, **as directed**.

F. Roof-Edge Flashings

1. Canted Roof-Edge and Fascia **OR** Fascia and Gravel Stop, **as directed**: Manufactured, two-piece, roof-edge fascia consisting of snap-on **OR** compression-clamped, **as directed**, metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed galvanized-steel sheet cant, 0.028 inch (0.71 mm) thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.
    - a. Fascia Cover: Fabricated from the following exposed metal:
        - 1) Formed Aluminum: 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
        - 2) Extruded Aluminum: 0.080 inch (2.03 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
        - 3) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.

    b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
    c. Splice Plates: Concealed **OR** Exposed, **as directed**, of same material, finish, and shape as fascia cover.
    d. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose fascia cover **OR** Cornice fascia cover **OR** Cove fascia cover, **as directed**.
    e. Fascia Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim **OR** Overflow scuppers **OR** Overflow scuppers with perforated screens **OR** Spillout scuppers **OR** Downspout scuppers with integral conductor head and downspout adapters **OR** Downspout scuppers with integral conductor head and downspout adapters and perforated screens, **as directed**.
2. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed- or extruded-aluminum anchor bar with integral drip-edge cleat to engage fascia cover. Provide matching corner units.
    a. Fascia Cover: Fabricated from the following exposed metal:
        1) Formed Aluminum: 0.032 inch (0.81 mm) thick **OR** 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
        2) Zinc-Coated Steel: Nominal 0.028 inch (0.71 mm) thick **OR** 0.034 inch (0.86 mm) thick **OR** thickness as required to meet performance requirements, **as directed**.
    b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
    c. Splice Plates: Concealed **OR** Exposed, **as directed**, of same material, finish, and shape as fascia cover.
    d. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose fascia cover **OR** Cornice fascia cover **OR** Cove fascia cover, **as directed**.
    e. Fascia Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim **OR** Overflow scuppers **OR** Overflow scuppers with perforated screens **OR** Spillout scuppers **OR** Downspout scuppers with integral conductor head and downspout adapters **OR** Downspout scuppers with integral conductor head and downspout adapters and perforated screens, **as directed**.
3. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding 12 feet (3.6 m), with a horizontal flange and vertical leg, drain-through, **as directed**, fascia terminating in a drip edge, **as directed**, and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.
    a. Fabricate from the following exposed metal:
        1) Copper: 16 oz./sq. ft. (0.55 mm thick) **OR** Weight (thickness) as required to meet performance requirements, **as directed**.
        2) Formed Aluminum: 0.032 inch (0.81 mm) thick **OR** 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
        3) Extruded Aluminum: 0.080 inch (2.03 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
        4) Stainless Steel: 0.025 inch (0.64 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
        5) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.
    b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
    c. Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim, **as directed**.
4. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

5. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.
7. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

G. Roof-Edge Drainage Systems
1. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
   a. Fabricate from the following exposed metal:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick) **OR** 20 oz./sq. ft. (0.68 mm thick), **as directed**.
      2) Formed Aluminum: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      3) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, thickness.
   b. Gutter Profile: Style A **OR** Style B **OR** Style F **OR** Style G **OR** Style H **OR** Style I **OR** Style K **OR** Style K highback **OR** Half-round single bead **OR** Half-round highback **OR** Quarter round **OR** Ogee **OR** As indicated, **as directed**, according to SMACNA's "Architectural Sheet Metal Manual."
   c. Embossed Surface: Embossed with design as indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   d. Applied Fascia Cover (Concealed Gutter): Exposed, formed copper, 16 oz./sq. ft. (0.55 mm thick) **OR** aluminum, 0.040 inch (1.02 mm) thick, **as directed**, with factory-mitered corners, ends, and concealed splice joints.
   e. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
   f. Gutter Supports: Gutter brackets **OR** Straps **OR** Spikes and ferrules **OR** Manufacturer's standard supports as selected by UT Health, **as directed**, with finish matching the gutters.
   g. Special Fabrications: Radiussed sections.
   h. Gutter Accessories: Continuous screened leaf guard with sheet metal frame **OR** Continuous hinged leaf guard of solid metal designed to shed leaves **OR** Continuous snap-in plastic leaf guard **OR** Bronze wire ball downspout strainer **OR** Wire ball downspout strainer **OR** Flat ends **OR** Bullnose ends for half-round gutter, **as directed**.
2. Downspouts: Plain round **OR** Corrugated round **OR** Plain rectangular **OR** Corrugated rectangular **OR** Open-face rectangular, **as directed**, complete with machine-crimped **OR** mitered **OR** smooth-curve, **as directed**, elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Formed Aluminum: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
   c. Extruded Aluminum: 0.125 inch (3.18 mm) thick.
   d. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, thickness.
3. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scuppers, **as directed**.
   a. Fabricate from the following exposed metal:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Formed Aluminum: 0.032 inch (0.81 mm) thick.

        3) Stainless Steel: 0.019 inch (0.48 mm) thick.
        4) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
4. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout, exterior flange trim, **as directed**, and built-in overflow, **as directed**.
    a. Fabricate from the following exposed metal:
        1) Copper: 16 oz./sq. ft. (0.55 mm thick).
        2) Formed Aluminum: 0.032 inch (0.81 mm) thick.
        3) Stainless Steel: 0.016 inch (0.40 mm) thick.
        4) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
5. Splash Pans: Fabricate from the following exposed metal:
    a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    b. Formed Aluminum: 0.040 inch (1.02 mm) thick.
    c. Stainless Steel: 0.019 inch (0.48 mm) thick.
    d. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
6. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.
7. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
    a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full rang, **as directed**.
8. Stainless-Steel Finish: No. 2B (bright, cold rolled, unpolished) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.
9. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
    a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

H. Reglets And Counterflashings
1. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
    a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    b. Formed Aluminum: 0.024 inch (0.61 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
    c. Stainless Steel: 0.019 inch (0.48 mm) **OR** 0.025 inch (0.64 mm), **as directed**, thick.
    d. Zinc-Coated Steel: Nominal 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm), **as directed**, thickness.
    e. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
    f. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
    g. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
    h. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
    i. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
    j. Multiuse Type, Embedded: For multiuse embedment in cast-in-place concrete **OR** masonry mortar joints, **as directed**.
2. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
    a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    b. Formed Aluminum: 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.

   c. Stainless Steel: 0.019 inch (0.48 mm) **OR** 0.025 inch (0.64 mm), **as directed**, thick.
   d. Zinc-Coated Steel: Nominal 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm), **as directed**, thickness.
3. Accessories:
   a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
   b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
4. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.
5. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Stainless-Steel Finish: No. 2B (bright, cold rolled, unpolished) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.
7. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

I. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
2. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
3. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Underlayment Installation
1. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
2. Self-Adhering Sheet Underlayment: Install wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water. Overlap edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
3. Polyethylene Sheet: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).

4. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

C. Installation, General
1. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.
    a. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
    b. Provide uniform, neat seams with minimum exposure of solder and sealant.
    c. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
    d. Torch cutting of roof specialties is not permitted.
    e. Do not use graphite pencils to mark metal surfaces.
2. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
    a. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
    b. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet **OR** self-adhering, high-temperature sheet underlayment **OR** polyethylene sheet, **as directed**.
    c. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
3. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
    a. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise shown on Drawings.
    b. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
4. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws **OR** substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance, **as directed**.
5. Seal joints with elastomeric **OR** butyl, **as directed**, sealant as required by roofing-specialty manufacturer.
6. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).
7. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm) except reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

D. Coping Installation
1. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
2. Anchor copings to meet performance requirements.
    a. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at 30-inch (760-mm) centers **OR** 40-inch (1015-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**.
    b. Interlock face leg drip edge into continuous cleat anchored to substrate at 24-inch (600-mm) centers **OR** 16-inch (400-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**. Anchor back leg of coping with screw fasteners

and elastomeric washers at 24-inch (600-mm) centers **OR** 16-inch (400-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**.

E. Roof-Edge Flashing Installation
  1. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
  2. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

F. Roof-Edge Drainage-System Installation
  1. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
  2. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches (305 mm) **OR** 24 inches (610 mm) **OR** 30 inches (762 mm), **as directed**, apart. Attach ends with rivets and seal with sealant **OR** solder, **as directed**, to make watertight. Slope to downspouts.
     a. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion joint caps.
     b. Install continuous leaf guards on gutters with noncorrosive fasteners, removable **OR** hinged to swing open, **as directed**, for cleaning gutters.
  3. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.
     a. Provide elbows at base of downspout to direct water away from building.

        OR

        Connect downspouts to underground drainage system indicated.
  4. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement **OR** elastomeric sealant, **as directed**.
  5. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
     a. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
     b. Loosely lock front edge of scupper with conductor head.
     c. Seal or solder exterior wall scupper flanges into back of conductor head.
  6. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch (25 mm) below scupper **OR** gutter, **as directed**, discharge.

G. Reglet And Counterflashing Installation
  1. General: Coordinate installation of reglets and counterflashings with installation of base flashings.
  2. Embedded Reglets: See Division 03 Section "Cast-in-place Concrete" and Division 04 Section "Unit Masonry" for installation of reglets.
  3. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.
  4. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with elastomeric **OR** butyl, **as directed**, sealant. Fit counterflashings tightly to base flashings.

H. Cleaning And Protection
  1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
  2. Clean and neutralize flux materials. Clean off excess solder and sealants.
  3. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal

filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

4. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

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SECTION 07 76 00 00 – PLAZA AND DECKS, CONSTRUCTION STANDARD

PART 1 - GENERAL

1.1 Scope of standard

A. The scope of this standard includes recommendations for the design and maintenance (retro-fit) of plazas and decks over occupied space(s). In general, plazas and decks over occupied space are not recommended. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 Related Standard

A. Structural Systems (currently UT Health Office of Facilities Planning and Construction Owner's Design Guidelines, Section K, Structural Criteria).

1.3 General Requirements

A. All plazas and decks situated over occupied space(s) shall have a redundant, bi- level drainage system to protect the occupied space(s) from water infiltration and damage.

1. The primary drainage system shall be at the top wearing surface exposed to weather and traffic.

2. Secondary drainage shall be provided below the wearing surface, at the membrane level, to drain any moisture that infiltrates down below the primary level protection at the wearing surface. The secondary drainage shall be provided by a pre-fabricated drainage grid, paver pedestals, or other method as required to provide free flow to the drains at the secondary level.

B. It is preferable to select a system that allows water to flow both on top of and below the wearing surface. Two systems that can be used separately or in a hybrid system are as follows:

1. An open joint system generally consists of individual paver units supported on pedestals with approximate 0.25 inch gaps between units.

2. A closed joint system generally consists of concrete surfaces or individual paver units with gaps filled with porous grout or sand, or the individual paver units placed in a lean mortar setting bed.

C. Paver units are preferable to large, monolithic concrete sections because pavers enhance drainage at the secondary level and long-term maintenance is simplified due to accessibility of the substrate (both the structural deck and the waterproofing system).

D. Provide a sloped substrate to insure adequate drainage at both the primary and secondary levels. Tapered insulation, sloped structural deck, variable pedestal heights, or other method(s) shall be used to accomplish this goal.

E. THE DESIGN OF PLAZAS AND DECKS SITUATED OVER OCCUPIED SPACE(S) SHOULD BE CONSIDERED EARLY IN THE DESIGN DEVELOPMENT OF A PROJECT SINCE THE EFFECT ON THE STRUCTURAL DESIGN AND OVERALL COST CAN BE SIGNIFICANT. The following items shall be considered in the design of plazas and decks situated over occupied space(s):

1. Slope of the structural deck (or if it currently is, in retro-fit applications).

2. Slope or contour of the wearing surface (or if it currently is, in retro-fit applications).

3. True clearance available between the substrate and the bottom of the wearing surface. At new conditions, this clearance should be optimized to assure proper drainage at the secondary level. In retro-fit applications, limitations may dictate the design of the overall system.
4. Type of drainage system and the limitations on drainage capacity.
5. Flashing at drains, rising walls, light pole supports, expansion joints, or any other feature that could effect overall adequacy of the drainage system.
6. Traffic and site feature loadings, as well as any possible pedestrian hazards caused by gaps between pavers, etc.
7. 7Aesthetics.

F. Walking surfaces shall be designed to be nominally level. Abrupt changes in elevation of walking surfaces shall not exceed 1/4 inch. The slope in the direction of travel shall not exceed 1 in 20. The slope perpendicular to the direction of travel shall not exceed 1 in 48.

PART 2 - PRODUCTS

2.1 SECONDARY DRAINAGE DETAILS

A. Secondary drainage shall be accomplished through the specification of one of the products indicated herein.

B. Insulation boards shall be a high density type that does not absorb moisture, have drainage slots scored in two directions into the bottom surface, and is able to withstand the superimposed loads without deflection, with resulting cracking, of the wearing surface.

2.2 MEMBRANE

A. A liquid-applied membrane completely adhered to the substrate will isolate leaks at their source and provide an easier way to trace locations requiring maintenance.

B. The membrane shall be a hot-applied, rubberized compound dispersed in asphalt with mineral fillers.

C. In high stress areas (rising wall flashings, penetrations, etc.) provide fabric reinforcing.

2.3 PAVER SYSTEM

A. The paver support system shall consist of one of the following types, depending on the needs for maintenance, accessibility, and loadings:

1. Individual pedestals constructed from high density polyethylene or blocks of high density foam board. Variable height pedestals may be required to provide the proper slope at the primary drainage level.
2. Continuous support on a pre-fabricated drainage grid. Pre-fabricated drainage grids allow for fast and efficient drainage of water at the membrane level.
3. Continuous support on a 1-2 inch pea gravel setting bed.
4. Continuous support on high density insulation board (approximately 100- 125 psi compressive strength) with drainage slots scored in two directions into the bottom surface.
5. Rigid supports fabricated from precast masonry units. This method of support is recommended in areas where pavers could be subjected to high density loading.

B. Where smaller poured concrete sections are required and the resulting system is closer in nature to a paver system than to a purely monolithic system, the support system shall consist of one of the following types, depending on the needs for maintenance, accessibility, and loadings:

1. Continuous support on a pre-fabricated drainage grid.
2. Continuous support on high density insulation board (approximately 100- 125 psi compressive strength) with drainage slots scored in two directions into the bottom surface.
3. Continuous support on a 1-2 inch pea gravel setting bed.
4. The method specified shall provide for proper placement of the concrete without blocking flow of water to or through the secondary drainage level.

2.4 MONOLITHIC CONCRETE SYSTEM

A. Paver systems are preferred. However, in the following cases a monolithic concrete system may need to be utilized:

1. Insufficient clearance to allow for the required clearance between the wearing surface and the substrate (structural deck).
2. The required finish contour of the plaza or deck will not accommodate a paver system.

B. Where a monolithic system is required, the monolithic concrete sections shall be designed in such sizes as to be removable for future repair of the substrate, including jointed, sealed sections with lifting inserts, or other method as may accomplish this goal.

C. Where applicable and cost effective, a combination of paver support systems and monolithic support systems may be considered to minimize the amount of monolithic concrete.

PART 3 - EXECUTION

3.1 Membrane

A. The membrane shall be constructed in the field by spreading the hot rubberized liquid over the structural deck to form a continuous, monolithic, seamless membrane completely adhered to the substrate.

3.2 Detailing

A. Detailing shall be in strict conformance with the manufacturer’s technical literature for the respective products.

B. Any products used shall conform to the waterproofing manufacturer’s recommendations and shall be supplied and installed in such as manner so as not to void or reduce the anticipated warranty. It is recommended that approval of the overall proposed design be obtained from the prospective waterproofing manufacturer(s) during the design development and final design processes.

END OF SECTION 07 76 00 00

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SECTION 07 84 00 00 – FIRESTOPPING

PART 1 - GENERAL

1.1. SUMMARY

A. Section Includes:
   1. Through Penetration Firestopping.
   2. Fire Resistive Joint Systems.

B. Related Sections
   1. Division 1 – General Requirements.
   2. Division 7 – Thermal and Moisture Protection.
   3. Division 9 – Finishes.
   4. Division 23 – Heating Ventilating and Air Conditioning.
   5. Division 26 – Electrical.

1.2. REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI/UL 263 - Fire Tests of Building Construction and Materials.
   2. ANSI/UL 723 - Surface Burning Characteristics of Building Materials.
   3. ANSI/UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.
   4. ANSI/UL 2079 - Tests for Fire Resistance of Building Joint Systems.

B. American Society for Testing and Materials(ASTM):
   1. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
   3. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Firestops.
   4. ASTM E 1399 - Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
   5. ASTM E 1966 - Standard Test Method for Fire Resistive Joint Systems.
   6. ASTM E 2174 - Standard Practice for On-Site Inspection of Installed Firestops.
   7. ASTM E 2307 - Fire Tests of Perimeter Fire Barrier Systems Using Intermediate Scale, Multi-Story Test Apparatus.
   8. ASTM E 2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.

C. Factory Mutual (FM) - FM4991 - Standard for Approval of Firestop Contractors.

D. International Code Congress (ICC):
   1. International Building Code (IBC).
   2. International Residential Code (IRC).
   3. International Mechanical Code (IMC)
   4. International Fire Code (IFC)

E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code.
   2. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
   3. NFPA 101 - Life Safety Code.

F. Underwriters Laboratories (UL) - UL Building Materials Directory:
   1. Through-Penetration Firestops Systems (XHEZ).
   2. Joint Systems (XHBN).
   3. Firestop Devices (XHJI).
   4. Forming Materials (XHKU).
   5. Wall Opening Protective Materials (CLIV).
   6. Fill Void or Cavity Materials (XHHW).

G. American Society of Sanitary Engineering (ASSE):
   1. ASSE Series 9000 – Professional Qualification Standard for Firestop Systems and Device Installers, Inspectors and Surveyors.

H. International Standards Organization (ISO):
   1 . ISO 6944
   2 . ISO 10295-1: 2007.
   3 . ISO 10295-2: 2009.
   4 . ISO 10295-3:

1.3. PERFORMANCE REQUIREMENTS

A. Provide systems that are listed by at least one the following:
   1. Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory".
   2. Intertek Testing Service (Formerly known as Omega Point Laboratories), in "Directory of Listed Products".
   3. Factory Mutual (FM), in FMRC Approval Guide.
   4. Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.

B. Provide firestop products that are flexible enough to allow for pipe vibration in a through penetration application.

C. Provide fire resistive sealants and sprays for construction joint applications that are flexible enough to satisfy the movement criteria per the test standards ASTM E 1399, ASTM E 1966 or ANSI/UL 2079.

D. Provide products with the appropriate flame spread index and smoke develop index, when tested in accordance with ASTM E 84.

E. Provide products that meet the intent of the L rating classification for the movement of smoke per ANSI/UL 1479 for through penetrations and ANSI/UL 2079 for construction joints.

F. Provide products identical to those tested and listed for classification by UL, Intertek or any other qualified independent testing agency.

G. Provide products that bear classification marking of qualified independent testing agency.

H. Where firestop systems not listed by any listing agency are required due to project conditions, submit a substitution proposal with evidence specified.

I. Use only products specifically listed for use in listed systems.

J. Provide products that are compatible with each other, with the substrates forming openings, and with the items, if any, penetrating the firestopping, under the conditions represented by this project, based on testing and field performance demonstrated by manufacturer.

K. Firestopping materials must meet and be acceptable for use by all building codes and NFPA codes cited in this section.

L. Provide products that meet the intent of the state or local guidelines on volatile organic compounds (VOC).

M. Where applicable provide products that meet the intent of the F rating classification for passage of flame per ANSI/UL 1479 for through penetrations.

N. Where applicable provide products that meet the intent of the T rating classification for the transfer of temperature per ANSI/UL 1479 for through penetrations.

O. Provide products that meet the intent of the L rating classification for the movement of smoke per ANSI/UL 1479 for through penetrations and ANSI/UL 2079 for construction joints.

P. Where applicable provide products that meet the intent of the W rating classification for passage of water per ANSI/UL 1479 for through penetrations.

1.4. SUBMITTALS

A. Submit under provisions of the Contract and Division 01 – General Requirements.

B. Shop Drawings: For each firestopping system, provide the following:
   1. Listing agency's detailed drawing showing opening, penetrating item(s), and firestopping materials, identified with listing agency's name and number or designation and fire rating achieved.
   2. For proposed systems that do not conform strictly to the listing, submit written instructions showing modifications and approved by firestop system manufacturer.
   3. Submit under provisions of the International Building Code (IBC) section 107 and 703 requiring a submittal package for fire-resistance ratings and fire tests.

C. Product Certificates: Submit certificates of conformance signed by firestop system manufacturer certifying that materials furnished comply with requirements.

D. Product Data: Furnish manufacturer's product data sheets on each material to be used in firestop systems. Information on manufacturer's product data sheet should include:
   1. Product characteristics including compliance with appropriate ASTM/UL/ANSI test standards.
   2. Storage and handling requirements and recommendations.

E. Installation Instruction: Furnish manufacturer's installation instructions.

1.5. QUALITY ASSURANCE

A. General: All through-penetration firestop systems and construction gap fire resistive systems shall be installed with approved methods using materials that have been tested and classified to produce an approved assembly.

B. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of twenty five (25) years experience.
   1. Products shall be manufactured in a facility that follows ISO 9001 best practices.

C. Installer Qualifications: Firm must be qualified by having experience, staff, and be properly trained to install the specified products, and meets the following criteria:
   1. Contractor is a 3M Master Contractor.
   2. Contractor is a Certified 3M Trained contractor.

3. Contractor is acceptable to manufacturer.
4. Contractor is acceptable to Authority Having Jurisdiction (AHJ).
5. Contractor has completed the manufacturer's certified product installation training.
6. Contractor must provide a list of completed projects as evidence of experience; include project name and address, owner's name and address, and architect's name and phone number.
7. Certificate: Contractor should provide certificate of qualification.

D. Codes: Where manufacturer's application procedures are in conflict with those of the local Authority Having Jurisdiction, the more strict guidelines will prevail.

E. Pre-installation Meetings: Meetings to agree on firestop requirements, conditions, manufacturer's instructions.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products until ready for installation in manufacturer's original unopened packaging, legibly marked with manufacturer's name and product identification, date of manufacture, lot number, listing agency's classification marking, curing/dry time, mixing instructions (if applicable) and MSDS reference number.

B. Store and handle in such a manner as to prevent deterioration or damage due to moisture, temperature changes, contaminants, and other causes; follow manufacturer's instructions.

C. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local Authority Having Jurisdiction.

1.7. PROJECT CONDITIONS

A. Coordinate construction and cutting of openings so that each particular firestop system may be installed in accordance with its listing, including assembly rating, L rating, sizing, sleeves, manufacturer's published STC rating and penetrating items.

B. Coordinate firestopping of dynamic and static construction joints (top-of-wall, bottom- of-wall, floor-to-floor, floor-to-wall), wall-to-wall, perimeter so that each particular system may be installed in accordance with its listing, including assembly rating, sizing, movement capabilities and manufacturer's published STC rating.

C. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install firestopping under environmental conditions outside manufacturer's absolute limits.

D. Provide ventilation as required by firestopping manufacturer, including mechanical ventilation if required.

1.8. WARRANTY

A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions, and exclusions from coverage.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Acceptable Manufacturer: 3M Fire Protection Products, www.3m.com/firestop.

B. Requests for substitutions will be considered in accordance with provisions of Division 1- General

Requirements.

C. Single Source: To maintain control and integrity of the firestop applications a single manufacturer should be used. Specific UL or approved listing agencies systems applicable to each type of firestop condition should be supplied by one manufacturer.

2.2. SCOPE/APPLICATION

A. Provide installed firestop products that limit the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, and similar locations, restoring the integrity of the fire rated construction to its original fire rating.

B. Provide firestop systems listed for the specific combination of fire-rated construction, type of penetrating item, annular space requirements, and fire rating, and the following criteria:
   1. F-Rating: Equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
   2. T-Rating: In habitable areas where penetrating items are exposed to potential contact with materials on fire side(s) of rated assembly, T-rating must equal its F-rating.
   3. L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum at ambient temperatures.
   4. W-Rating: meets UL Water Leakage Test, W Rating – Class 1 requirements for systems tested and listed in accordance with ANSI/UL 1479.
   5. Wall Penetrations: Through penetration systems must be symmetrical, with the same rating from both sides of the wall. Membrane penetrations may be asymmetrical.
   6. Testing: Determine ratings in accordance with ASTM E 814 or UL 1479.

C. Provide fire-resistive systems listed for construction gaps per the specific combination of fire-rated construction type, configuration, gap dimensions, and fire rating, and the following criteria:
   1. Fire resistance rating must be equal to or greater than that of the assembly in which it is to be installed.
   2. Movement capability must be appropriate to the potential movement of the gap, demonstrated by testing in accordance with ASTM E 1399/ASTM E 1966/UL 2079 for minimum of 500 cycles at 10 cycles per minute.
   3. L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum.
   4. Determine ratings in accordance with ASTM E 1966/UL 2079.

2.3. THROUGH PENETRATION FIRESTOP PRODUCTS

A. 3M Fire Barrier Sealant 2000 NS: Single-part, non-slump elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, nonmetallic pipe (FGG/BM system CPVC compatible), conduit, power and communication cable and telephone or electrical wiring.
   1. Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
   2. Locations: Vertical and horizontal assemblies.
   3. STC-Rating of 56 when tested in STC 56-rated wall assembly.

B. 3M Fire Barrier Moldable Putty+: One-part, 100 percent solids intumescent firestop. Remains pliable, flexible and easily re-enterable. Non-toxic synthetic formula. Versatile putty for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
   1. Type: Stick or Pad

2. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
3. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

C. 3M Fire Barrier 2001 Silicone RTV Foam: Two-part, liquid-silicone elastomer, foams in place when mixed. For use sealing large or complex openings such as cable bundles, cable trays and conduit banks.
   1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
   2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

D. 3M Fire Barrier Pillow: Self-contained, intumescent firestop product. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
   1. Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
   2. Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

2.4. FIRESTOPPING FOR SINGLE MEMBRANE PENETRATIONS

A. 3M Fire Barrier Moldable Putty+: One-part, 100 percent solids intumescent firestop. Remains pliable, flexible and easily re-enterable. Non-toxic synthetic formula.
   1. Type: Pad.
   2. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.

B. 3M Endothermic Mat E-5A-4: Endothermic heat absorbing mat.
   1. Type: Mat.
   2. Fire Resistance: For use in 1 or 2 hour fire rated systems.

PART 3 – EXECUTION

3.1. EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.

C. Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.

D. Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.

E. Verify that environmental conditions are safe and suitable for installation of firestopping.

F. If substrate preparation is the responsibility of another installer, notify Architect or Engineer of Record of unsatisfactory preparation before proceeding.

3.2. PREPARATION

A. Prepare substrates in accordance with manufacturer's instructions and recommendations.
B. Install masking and temporary coverings as required to prevent contamination or defacement of adjacent surfaces due to firestopping installation.

3.3. INSTALLATION

A. Install in strict accordance with manufacturer's detailed installation instructions and procedures.

B. Install so that openings are completely filled and material is securely adhered.

C. Where firestopping surface will be exposed to view, finish to a smooth, uniform surface flush with adjacent surfaces.

D. After installation is complete, remove combustible forming materials and accessories that are not part of the listed system.

E. Repair or replace defective installations in accordance with manufacturer’s recommendations, listed systems details and applicable code requirements.

F. At each through penetration or fire-resistive joint system, attach identification labels on both sides in location where label will be visible to anyone seeking to remove penetrating items or firestopping.

G. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned.

H. Notify Authority Having Jurisdiction when firestopping installation is ready for inspection; obtain advance approval of anticipated inspection dates and phasing, if any, required to allow subsequent construction to proceed.

I. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.

3.4. FIELD QUALITY CONTROL

A. Owner will engage an independent testing agency to inspect installed firestopping and to prepare reports indicating whether the installed work complies with the contract documents.

B. Notify testing agency at least 7 days prior to date when firestopping installation will be ready for inspection; obtain advance approval of general schedule and phasing, if any, required to allow subsequent construction to proceed.

3.5. CLEANING AND PROTECTION

A. Remove left over material and debris from Work area. Use necessary means to protect fire protection product(s) before, during, and after installation.

B. Touch-up, repair or replace damaged products before Substantial Completion.

C. Install identification Labels for Through Penetration and Construction Joint Systems: Pressure sensitive self-adhesive vinyl labels, preprinted with the following information:

1. The applicable words "Warning - Through Penetration Firestop System – Do not Disturb. Notify Building Management of Any Damage." or "Warning – Construction Gap Fire Resistive System - Do not Disturb. Notify Building Management of Any Damage."
2. Listing agency's system number or designation.
3. System manufacturer's name, address, and phone number.
4. Installer's name, address, and phone number.
5. General contractor's name, address, and phone number (if applicable).
6. Date of installation.

END OF SECTION 07 84 00 00

SECTION 07 91 26 00 – JOINTING FILLERS

PART 1 - GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of UT HEALTH for jointing of exterior vertical surfaces for the following materials:

1 Concrete

2 Masonry

B. UT HEALTH recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Related Standards

A. The Secretary of the US Department of the Interior's Standards for Rehabilitation.

B. Conservation of Building and Decorative Stone, 2 vols., John Asbury.

C. Technical Notes on Brick Construction, Brick Industry Association.

D. Masonry Veneer (Second Edition), Masonry Institute of America.

1.03 Definitions

A. Construction joint

1 Construction joints shall be located where construction will be facilitated or where the lack of a joint could cause the lack of structural integrity in the completed structure.

2 Construction joints are theoretically undetectable in the completed structure and shall not cause any reduction in structural capacity or integrity.

B. Control joint

1. Control joints include expansion and contraction joints and are intended to provide for movement in the structure in order to "control" any possible movements that may have an impact on the structural integrity of the completed structure.

2. Control joints also act as construction joints.

3. Control joints are often referred to as movement joints.

C. Expansion joint

1 Expansion joints are control joints that are designed to allow for the expansion of the concrete or masonry.

2 Expansion joints also act as contraction joints.

D. Contraction joint

1. Contraction joints are control joints that are designed to allow for the contraction of the concrete or masonry.

1.04 General Requirements:

A. Jointing shall be integral with the architectural/ structural design and detailing, not added at the end of the design process to satisfy minimum requirements.

B. This standard gives some general guidelines for the locations and sizes of joints. However, jointing design is dependent on the materials selected, the makeup of the materials, environmental conditions, and the architectural/structural design and detailing. Factors to be considered are:

1 Temperature effects.
2 Shrinkage effects.
3 Creep.
4 Stresses caused by the architectural/structural design.
5 Moisture effects.

C. All expansion and contraction joints shall be shown and detailed by the Engineer or Architect.

D. Critical construction joints shall be planned for and shown on the drawings, with guidelines for other construction joints specified in section 03300, Cast-in-place Concrete, to be prepared as a part of the contract documents. Other proposed construction joints as specified in section 03300 shall be submitted by the Contractor to the Engineer for review and approval during construction.

PART 2: PRODUCTS

2.01 Joint Sealant

A. Unless otherwise required for specialized conditions, joint sealant shall be a moisture-cured, single- or multi-component (depending on the application and required expansion/contraction capabilities), polyurethane-base, non-sag, elastomeric sealant.

B. Sealant depth-to-width ratio at the center of the joint shall be 1:2.

C. Allowable expansion/contraction of the joint shall be ± 25 - 50% of joint width, depending on the product capabilities.

D. Where applicable, provide a compatible sealant primer.

2.02 Backer

A. Joint sealant backer is required for all applications.

B. Unless otherwise required for specialized conditions, joint sealant backer shall be a closed-cell, polyethylene rod.

C. Where limitations prevent the use of a backer rod, specify a polyethylene, self-adhesive, bond-breaker tape shall be used.

2.03 Filler

A. Joint filler shall be specified to provide filling of the gap and to prevent displacement and improper location of the backer.

B. Joint filler shall be a continuous, non-bleeding material compatible with the joint conditions.

PART 3: EXECUTION

3.01 Construction Joints

A. Locate construction joints where anticipated stresses are low.

B. Before placing new material against the completed side of the joint, clean the joint thoroughly and specify a bonding agent, mortar, lean grout, etc., as required to meet the definition and function of a construction joint.

C. Structural reinforcing shall be 100% continuous across the joint.

D. Where applicable, waterstops shall be provided for watertightness.

3.02 Control Joints

A. Expansion joints

1. Locate expansion joints to accommodate anticipated expansion at abrupt changes in the structure, where butting up to existing structures, and at least one corner of windows, doors, and other rectangular openings.
2. The spacing of joints shall be contingent on the material's capacity to sustain expansion without damage to the concrete or masonry (usually based on the amount of reinforcing).
3. Structural reinforcing shall be discontinuous across the joint. Terminate reinforcing a minimum of two (2) inches from the faces of the joint.
4. Smooth reinforcing dowels, properly detailed, shall be provided to prevent movement out of the plane of the vertical surface and to provide for shear transfer (as required).
5. The minimum expansion joint width shall be 1/4".
6. Expansion joints shall be sealed.
7. Where applicable, waterstops shall be provided for watertightness.

B. Contraction joints

1 Locate contraction joints to accommodate anticipated contraction, usually at a set spacing of between 15 - 30 feet.

2 The spacing of joints is contingent on the material's capacity to sustain expansion without damage to the concrete or masonry (usually based on the amount of reinforcing).

3 Maximum structural reinforcing shall be 50% continuous across the joint. Terminate non-continuous reinforcing a minimum of two (2) inches from the faces of the joint.

4 Smooth reinforcing dowels properly detailed can be provided to prevent movement out of the plane of the vertical surface and for shear transfer across the joint if the normal reinforcing detailed is not adequate.

5 The minimum contraction joint depth shall be 3/4 - 1 inch.

6 Typically, contraction joints are sealed.

7 Where applicable, waterstops shall be provided for watertightness.

C. Control joints shall not abruptly terminate in the middle of a vertical surface. (For example, do not discontinue joints at parapets, but continue joints through the parapet.)

3.03 Concrete: The following guidelines are in addition to those noted above and refer specifically to concrete:

A. Contraction joints in concrete shall be installed according to one of the following methods:

1. Pre-manufactured strips that are set in with the concrete and removed during or after the curing process of the concrete.
2. Saw-cutting. To be effective, saw-cutting must occur as soon as possible after concrete placement. Many factors influence the timing of saw-cutting, including weather conditions, concrete mix design, curing, and time of placement. However, the following general guidelines shall apply:

Hot/dry conditions. Saw-cut within 4- 12 hours.

Cool moist conditions. Saw-cut within 24 hours.

B. Contraction joints in concrete shall be provided at the following locations:

1. At major changes in wall heights.
2. At changes in wall thickness.

3.04 Masonry: The following guidelines are in addition to those noted above and refer specifically to masonry:

A. Expansion joints in masonry shall be provided at the following locations:

1. Below shelf angles or structural frames supporting masonry walls or panels.
2. Above masonry walls or panels abutting structural frames.
3. At major changes in wall heights.
4. Near wall intersections.
5. At regular intervals, not to exceed 25’-0.”

B. Contraction joints in masonry shall be provided at the following locations:

1. At major changes in wall heights.
2. At changes in wall thickness.
3. Above joints in foundations.
4. At columns and pilasters.
5. At one or both sides of wall openings.
6. Near wall intersections.

END OF SECTION 07 91 26 00

SECTION 07 95 13 00 – EXPANSION JOINT COVER ASSEMBLIES

SECTION 07 95 13 00 - EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain expansion joint cover assemblies specified in this Section from one source from a single manufacturer. Coordinate compatibility with expansion joint cover assemblies specified in other sections.

B. Fire Test Response Characteristics: Where indicated, provide expansion joint cover assemblies identical to those assemblies whose fire resistance has been determined per ANSI/UL 263, NFPA 251, U.B.C. 43 1, or ASTM E 119, including hose stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.

   1. Fire Resistance Ratings: Not less than the rating of adjacent construction.

2. SUBMITTALS

C. Samples:

   1. Samples for initial selection purposes in the form of manufacturer's color charts, actual units, or sections of units showing full range of colors, textures, and patterns available for each exposed metal and elastomeric material of expansion joint cover assembly indicated.

   2. Samples for verification purposes in full size units of each type of expansion joint cover assembly indicated; in sets for each finish, color, texture, and pattern specified, showing full range of variations expected in these characteristics.

      a. Install elastomeric material for joints samples to verify color selected.

D. Record Documents:

   1. Shop drawings showing fabrication and installation of expansion joint cover assembly including plans, elevations, sections, details of components, joints, splices, and attachments to other units of Work.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. To establish standards of manufacture, operation, performance, and appearance, Drawings and Specifications are based on products scheduled for each joint type. Provided compliance with requirements, products of the following manufacturers will also be acceptable:

1. Balco Inc.

2. Or Approved Equal

3. EXPANSION JOINT COVER ASSEMBLIES

B. Provide expansion joint cover assemblies of design, basic profile, materials, and operation indicated. Provide units comparable to those indicated or required to accommodate joint size, variations in adjacent surfaces, and dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399. Furnish units in longest practicable lengths to minimize number of end joints. Provide hairline mitered corners where joint changes directions or abuts other materials. Include closure materials and transition pieces, tee joints, corners, curbs, cross connections, and other accessories as required to provide continuous joint cover assemblies.

C. Moisture Barrier: Provide manufacturer's continuous, standard, flexible vinyl moisture barrier under covers at locations indicated.

D. Fire Rated Joint Covers: Provide expansion joint cover assemblies with manufacturer's continuous, standard, flexible fire barrier seals under covers at locations indicated to provide fire resistive rating not less than the rating of adjacent construction.

E. Coverless Fire Barrier: Provide manufacturer's continuous standard flexible fire barrier seals at locations indicated to provide fire resistive rating not less than the rating of adjacent construction.

2.3 JOINT COVER SCHEDULE

A. Provide the following expansion joint cover types at locations indicated:

1. Expansion Joint Type 1: Floor; Construction Specialties Model ELY, 1 inch Width.

2. Expansion Joint Type 2: Floor; Construction Specialties Model ELY, 2 inch Width.

3. Expansion Joint Type 3: Floor; Construction Specialties Model ALR-M, 1 inch Width.

4. Expansion Joint Type 4: Wall & Ceiling; Construction Specialties Model EAFW, 1 inch and 2 inch Width.

5. Expansion Joint Type 5: Roof to Roof, Roof to Wall; 1-1/2 inch to 4-1/2 inch width; Schuller Corporation Model TL-6.

B. Expansion Joint Cover Types for Bertner Complex; Patient Care Tower and Research Building:

1. Expansion Joint Type 3; Floor to Floor: D & B Expansion Joints Model FA 100-T.

2. Expansion Joint Type 4; Floor to Floor: Construction Specialties Model ALR-1.

3. Expansion Joint Type 5; Wall to Wall: Construction Specialties Model AFW-1.

4. Expansion Joint Type 6; Ceiling to Ceiling: Construction Specialties Model HC-1.
5. Expansion Joint Type 7; Wall to Wall/Ceiling to Ceiling: Construction Specialties Model SM-1N.
6. Expansion Joint Type 8; Floor to Wall: Construction Specialties Model ALRW-1.
7. Expansion Joint Type 9; Wall to Wall: Construction Specialties Model AFWC-1.
8. Expansion Joint Type 10; Floor to Floor: MM Systems Model FS-100.
9. Expansion Joint Type 11; Wall to Wall: MM Systems Model FS-W.
10. Expansion Joint Type 12; Floor to Wall/Floor: MM Systems Model FS-NE-100.
11. Expansion Joint Type 13; Wall to Wall: MM Systems Model FS-W.
12. Expansion Joint Type 14; Wall to Wall/Corner: MM Systems Model FS-W-(Corner).

C. Expansion Joint Cover Types for Clinic Services and Gimbel Mechanical:

1. Expansion Joint Type 1; Floor to Floor: Construction Specialties Model ALR-1M.
2. Expansion Joint Type 2; Floor to Floor: Construction Specialties Model ALR-2.
3. Expansion Joint Type 3; Wall to Wall: Construction Specialties Model EAFW-1.
4. Expansion Joint Type 4; Ceiling to Ceiling: Construction Specialties Model FWF-100.
5. Expansion Joint Type 5; Floor to Wall: Construction Specialties Model ALAW-1.
6. Expansion Joint Type 6; Wall to Wall: Construction Specialties Model EACW-1.
7. Expansion Joint Type 7; Wall to Wall: Construction Specialties Model EAFW-1 1/2.
8. Expansion Joint Type 8; Floor to Floor: Construction Specialties Model ALR-1 1/2.

D. Fire Barrier Insert: Construction Specialties Model FB-88.

2.4 MATERIALS

A. Aluminum: ASTM B 221, alloy 6063 T5 for extrusions; ASTM B 209, alloy 6061 T6, sheet and plate.

1. Protect aluminum surfaces to be placed in contact with cementitious materials with a protective coating.

B. Bronze: ASTM B 455, alloy C38500 for extrusions; alloy C28000 Muntz Metal for plates.

C. Brass: UNS alloy C26000 for half hard sheet and coil.

D. Stainless Steel: ASTM A 167, Type 304 with 2B finish, unless indicated otherwise, for plates, sheet, and strips.

E. Extruded Preformed Seals: Single or multicellular elastomeric profiles as classified under ASTM D 2000, designed with or without continuous, longitudinal, internal baffles. Formed to fit compatible frames, in color indicated or, if not indicated, as selected by Owner from manufacturer's standard colors.

F. Preformed Sealant: Manufacturer's standard elastomeric sealant complying with ASTM C 920, Use T, factory formed and bonded to metal frames or anchor members; in color indicated or, if not indicated, as selected by Owner from manufacturer's standard colors.

1. Joints 2 Inches Wide and Less: Withstand plus or minus 35 percent movement of the joint width without failure.

2. Joints Greater Than 2 Inches to 4 Inches Wide: Withstand plus or minus 50 percent movement of the joint width without failure.

G. Seismic Seals: Typically for exterior application, two single layered elastomeric profiles, one interior and one exterior, as classified under ASTM D 2000; retained in a set of compatible frames, in color indicated or, if not indicated, as selected by Owner from manufacturer's standard colors. At manufacturer's option, omit interior profile for interior application.

H. Fire Barriers: Designed for indicated or required dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399. Tested in maximum joint width condition with a field splice as a component of an expansion joint cover per ANSI/UL 263, NFPA 251, U.B.C. 43 1, or ASTM E 119, including hose stream test of vertical wall assemblies by a nationally recognized testing and inspecting agency acceptable to authorities having jurisdiction.

I. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesive, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.5 METAL FINISHES

A. Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes to products in factory after fabrication. Protect finishes on exposed surfaces before shipment.

B. Coordinate expansion joint cover work with similar work in adjacent areas and match finishes of metal and elastomeric components to those in adjacent areas unless otherwise indicated.

C. Aluminum Finishes: Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.

1. Mill Finish: AA M10 (unspecified mill finish).

2. Class II, Clear Anodized Finish: AA M12C22A31 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, clear film thicker than 0.4 mil).

3. Class I, Clear Anodized Finish: AA M12C22A41 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, clear film thicker than 0.7 mil) complying with AAMA 607.1.

4. Class II, Color Anodized Finish: AA M12C22A32/A34 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, film thicker than 0.4 mil with integral color or electrolytically deposited color).

5. Class I, Color Anodized Finish: AA M12C22A42/A44 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, film thicker than 0.7 mil with integral color or electrolytically deposited color) complying with AAMA 606.1 or AAMA 608.1.

    a. Color: Light bronze

    b. Color: Medium bronze

    c. Color: Dark bronze

    d. Color: Black

   e. Color: Match Architect's sample

   f. Color: As selected by Owner from within standard industry colors and color density range.

   g. Factory Primed Concealed Surfaces: Protect concealed metal surfaces to be placed in contact with concrete or masonry with a shop coat of manufacturer's standard primer on the contact surfaces.

D. Bronze Finish: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

   1. Natural Satin Finish: CDA Designation M32, mechanical finish, directional textured, medium satin.

E. Stainless Steel Finishes: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

   1. Bright, Cold Rolled Unpolished Finish: AISI No. 2B finish

   2. Bright, Directional Polish: AISI No. 3 finish

F. Factory Finish: Manufacturer's standard factory finish

PART 3 - EXECUTION

3.1 PREPARATION

A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for phases of Work, including preparing substrate, applying materials, and protecting installed units.

B. Coordinate and furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in or anchored to concrete or to have recesses formed into edges of concrete slab for later placement and grouting in of frames.

C. Fastening to In Place Construction: Provide anchorage devices and fasteners where necessary to secure expansion joint cover assemblies to in place construction, including threaded fasteners with drilled in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and provide for secure attachment of expansion joint cover assemblies.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Perform cutting, drilling, and fitting required to install expansion joint covers. Install joint cover assemblies in true alignment and proper relationship to expansion joints and adjoining finished surfaces measured from established lines and levels. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling. Set floor covers at elevations to be flush with adjacent finished floor materials. Locate wall, ceiling, roof, and soffit covers in continuous contact with adjacent surfaces. Securely attach in place with required accessories. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches on center.

D. Maintain continuity of expansion joint cover assemblies with a minimum number of end joints and align metal members mechanically using splice joints. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere flexible filler materials (if any) to frames with adhesive or pressure sensitive tape as recommended by manufacturer.

E. Extruded Preformed Seals: Install seals complying with manufacturer's instructions and with minimum number of end joints. For straight sections provide preformed seals in continual lengths. Vulcanize or heat weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer. Apply adhesive, epoxy, or lubricant adhesive approved by manufacturer to both frame interfaces before installing preformed seal. Seal transitions according to manufacturer's instructions.

F. Elastomeric Sealant Joint Assemblies: Seal end joints within continuous runs and joints at transitions according to manufacturer's directions to provide a watertight installation.

G. Seismic Seals: Install interior seals in continual lengths; vulcanize or heat weld field splice joints in interior seal material to provide watertight joints using manufacturer's recommended procedures. Install exterior seal in standard lengths. Seal transitions and end joints according to manufacturer's instructions.

H. Fire Barriers: Install fire barriers, including transitions and end joints, according to manufacturer's instructions so that fire rated construction is continuous.

3.3 CLEANING AND PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's instructions.

END OF SECTION 07 95 13 0092 00 0095 13

SECTION 08 11 13 00 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Doors, panels, and frames shall be from a current member of the Steel Door Institute and comply with all SDI Standards and Guidelines for fabrications and execution of manufactured products.

B. Provide custom steel doors and frames manufactured by a single firm specializing in the production of this type of work, unless otherwise acceptable to the Architect.

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

   1. Test Pressure: Test at atmospheric pressure.

   2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide manufacturer’s certification that doors conform to all standard construction requirements of tested and labeled fire-rated door assemblies except for size.

   3. Temperature Rise Rating: At stairwell enclosures, provide doors that have a temperature rise rating of 450 degrees F (232 degrees C) maximum in 30 minutes of fire exposure.

1.4 SUBMITTALS

A. Product Data:

   1. Product data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, sound ratings, profiles, and finishes.

B. Record Documents:

   1. Shop Drawings: For fabrication and installation of custom steel doors and frames work. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections, and glazing installation details and trim.

a. Coordinate submittals with other doors, frames, and hardware and use the same “opening number identification” as given on the Drawings and the Door Schedule.

1) Submittals not using the numbering identification shown on Drawings and Schedules will be rejected.

2. Label Construction Certification: For door assemblies required to be fire-rated and that exceed limitations of labeled assemblies, submit manufacturer’s certification that each door and frame assembly has been constructed to conform to design, materials and construction equivalent to requirements for labeled construction.

1.5 DELIVERY, STORAGE and HANDLING

A. Frames shall include shipping bar at bottom to insure frame integrity during shipping. All shipping bars shall be removed prior to frame installation.

B. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to the Architect; otherwise remove and replace damaged items as directed.

C. Store doors and frames at the building Site under cover. Place units on minimum 4-inch high wood blocking. Avoid the use of nonvented plastic or canvas shelters that could create a humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately. Provide ¼-inch spaces between stacked doors to promote air circulation.

1.6 warranty

A. All hollow metal work shall be warranted from defects in workmanship and quality for a period of one (1) year from the date of substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include:

1. Hollow Metal Doors

a. Curries Manufacturing Inc., 747 Series

b. CECO, Medallion

c. Steelcraft, B Series

d. Or Approved Equal

2. Hollow Metal Frames

a. Curries Manufacturing Inc., M Series

b. CECO, SU Series

c. Steelcraft, F Series

d. Or Approved Equal

3. Stainless Steel Doors and Frames

a. Krieger

b. Overly

c. Fleming

d. Or Approved Equal

2.3 MATERIALS

A. Hot-Rolled Steel Sheets: ASTM A 569/A 569M, CS (Commercial Steel), Type B; free of scale, pitting or surface defects; pickled and oiled.

B. Cold-Rolled Steel Sheets: ASTM A 366/A 366M, CS (Commercial Steel), Type B.

C. Metallic-Coated (Galvanized) Steel Sheets: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (AZ180) zinc-iron-alloy (galvannealed) coating.

D. Stainless-Steel Sheets: Tension leveled stainless steel to ASTM A167-92b, Type 319.

E. Supports and Anchors: Fabricate of not less than 16-gage sheet metal. Galvanize after fabrication units to be built into exterior walls, complying with ASTM A 153, Class B.

F. Inserts, Bolts, and Fasteners: Manufacturer's standard units, except hot-dip galvanize items to be built into exterior walls, complying with ASTM A 153, Class C or D as applicable.

G. Shop-Applied Paint: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as base for specified finish paints on steel surfaces.

2.4 FABRICATION, GENERAL

A. Fabricate hollow metal units to be rigid, neat in appearance, and free from defects, warp, or buckle. Accurately form metal to required sizes and profiles. Wherever practicable, fit and assemble units in the manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at the Project Site. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Metallic filler to conceal manufacturing defects is not acceptable.

1. Interior Doors: Minimum 16-gauge face sheets.

2. Exterior Doors: Minimum 14-gauge face sheets.

B. Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

C. Sound-Rated (Acoustical) Assemblies: Wherever shown or scheduled, provide door and frame assemblies that have been fabricated as sound-reducing type, tested in accordance with ASTM E 90, and classified in accordance with ASTM E 413.

1. Unless otherwise indicated, provide acoustical assemblies with sound ratings of STC 33 or better.

D. Finish Hardware: Prepare doors and frames to receive finish hardware, including cutouts, reinforcing, mortising, drilling, and tapping with reinforcing plated from same steel finish (not gauge) as door face sheets, in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI/SDI A250.6 standards for door and frame preparation for hardware.

1. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at Project Site.

2. Stainless steel doors shall be internally reinforced with Type 316 Stainless Steel for surface mounted hardware and cutout, drilled and tapped to receive mortised hardware according to ANSI/SDI A250.6 with reinforcing plates from the same steel finish (not gauge) as door face sheets.

3. Locate finish hardware as shown on final Shop Drawings, or if not shown, in accordance with “Recommended Locations for Builder’s Hardware for Custom Steel Doors and Frames,” published by Door and Hardware Institute.

4. Finish Hardware Reinforcement: Minimum gauges of steel reinforcing plates for the following hardware:

   a. Hinges and Pivots: 7 gauge thick by 1.5” wide by 6” longer than hinge, secured by no less than six (6) spot welds.

   b. Strikes, Flush Bolts and Closers: 12 gauges.

   c. Surface-mounted Hold-Open Arms and Panic Devices: 12 gauge.

5. All hollow metal doors over 3 feet in width (requiring heavy weight hinges) shall receive a full mortise, aluminum, continuous geared hinge.

E. Clean, treat, and paint exposed surfaces of steel doors and frames, including galvanized surfaces, but excluding stainless steel surfaces.

1. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.

2. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC-PT2), hot phosphate solution (SSPC-PT4), or basic zinc chromate-vinyl butyryl solution (SSPC-PT3).

3. Apply shop coat of prime paint within time limits recommended by pretreatment manufacturer. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.

F. Provide stops and moldings around solid, glazed, and louvered panels where indicated.

1. Form fixed stops and moldings integral with frame, unless otherwise indicated.

2. Provide removable stops and moldings where indicated or required, formed of not less than 20-gage steel sheets matching steel of frames. Secure with countersunk flat or oval head machine screws spaced uniformly not more than 12 inches on center. Form corners with butted hairline joints.

3. Coordinate width of rabbet between fixed and removable stops with type of glass or panel and type of installation indicated.

2.5 DOORS

A. Provide flush design doors, 1-¾ inches thick:

1. Interior Doors
    a. Series: 747
    b. Gauge: 16 (14 at interior sensitive openings)
    c. Core: 22 gauge steel stiffeners spaced not more than 6 inches apart with fiberglass batting between the channels.
    d. Steel: Cold-rolled
    e. Edges: SEAMLESS-Intermittently welded edge, grind smooth, fill and touch-up with primer paint, free from blemishes.
2. Exterior Doors
    a. Series: 747
    b. Gauge: 14
    c. Steel: A60 Galvannealed
    d. Edges: SEAMLESS-Intermittently welded edge, grind smooth, fill and touch-up with primer paint, free from blemishes.
3. For single-acting swing doors, bevel both vertical edges 1/8 inch in 2 inches lock and hinge edge, unless doors are double acting or sliders.. For double-acting swing doors, round vertical edges with 2-1/8 inch radius.
4. Unless otherwise required for acoustical or thermal doors, provide filler of fiberboard, mineral-wool board, or other insulating material solidly packed full door height to fill voids between inner core reinforcing members.
5. Reinforce doors with rigid tubular frame where stiles and rails are less than 8 inches wide. Form tubular frame with 16-gage steel, welded to outer sheets.
6. Provide internal core constructed of galvanized, stretcher-leveled steel sheets not less than 18-gage, vertically reinforced with galvanized sheet steel sections not less than 22 gage, spaced 6 inches on center, extending full height of door and spot welded to both face sheets at not more than 5 inches on center.
    a. Continuous truss-form reinforcement of 28-gage galvanized steel may be provided in lieu of spaced steel sections. Spot weld truss-form reinforcement 3 inches on center vertically and horizontally over entire core surface on both sides.
7. Reinforce tops and bottoms of doors with galvanized, 18-gage, horizontal steel channels, welded continuously to core faces. For exterior stainless steel doors, close top and bottom edges to provide weather seal.

B. Stainless Steel Doors

1. Interior Doors
    a. Series: Doors shall be completely fabricated from commercial grade; tension leveled stainless steel to ASTM A167-92b, Type 316. Face sheets and glazing trims shall be (XL Blend S-Brushed) finish. Balance components shall be Mill finish.
    b. Gauge: 16

- c. Core: 22 gauge steel stiffeners space no more than 6 inches apart with fiberglass batting between the channels of polystyrene core.
- d. Stainless Steel: Tension leveled stainless steel to ASTM A167-92b, Type316
- e. Edges: Visible Edge seam is permitted; if Seamless edge is required by UTHSC-SA Project Manager, then continuously weld edge, grind smooth, free from blemished with and XL blend S-brushed Finish.

2. Doors shall be beveled 1/8” in 2” lock and hinge edge, unless doors are double acting sliders.

3. Provide stainless steel hardware at stainless steel doors.

4. Stainless steel cladding doors will not be accepted.

5. Provide #4 polish on exposed surfaces with vertical grain direction unless shown otherwise.

C. Fire rated doors require metal applied label indicating rating designation.

D. <u>Provide High Frequency High Reinforcement at all top hinge location for doors 3’-0” in width and 7’-0” in height and over or provide continuous 12 gauge continuous one piece formed and tapped for hinges.</u>

E. Electrified Openings

1. Doors shall be pre-wired with sufficient number of concealed wires to accommodate electric function of specified hardware. Provide Molex type standardized plug in connectors to accommodate up to 12 wires.

2.6 FRAMES

A. Fabricate frames of full-welded unit construction, with corners mitered, reinforced, continuously welded full depth and width of frame. Knock-down type frames are not acceptable.

1. Interior Frames:
   - a. Profile: M Series<u>(No double drywall returns), Equal Rabbet</u> at new construction over 50 openings.
   - b. Gauge: 16 at openings up to and including 3’-0” wide (14 at interior security sensitive openings).
   - c. Steel: Cold-rolled steel or: A60 galvannealed at restrooms with showers, clean rooms such as “Surgery and Laboratories,” and other rooms where high moisture content is applicable.
   - d. Welding: Continuous face welded, dressed and ground smooth, prime paint.

2. Exterior Frames:
   - a. Profile: M Series(No double drywall returns), Equal Rabbet.
   - b. Gauge: 14.
   - c. Steel: A60 galvannealed.
   - d. Welding: Continuous face welded, back weld, dressed and ground smooth, prime paint.

3. Form frames of stainless steel sheets with #4 polish for openings indicated to receive stainless steel doors.

4. Stainless Steel Frames:

   a. Profile: No double drywall returns

   b. Gauge: 16 at openings up to and including 3’-0” wide. 14 at openings over 3’-0” wide.

   c. Stainless Steel: Type 316 as designed in “Surgery and Laboratories” per UTHSC-SA Project Manager.

   d. Welding: Continuous face welded corners, dressed and ground smooth, with brushed finish (XL Blend S).

   e. Provide 316 welded in place anchors for attaching to wall framing members.

   f. Provide stainless steel door hardware at stainless steel frames.

   g. Provide closed or tubular mullions and transom bars where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.

5. Provide false head member to receive lower ceiling where frames extend to finish ceilings of different heights.

B. Provide High Frequency Reinforcement at all top hinge locations for frames 3’-0” in width and 7’-0” in height and over.

C. Jamb Anchors: Furnish jamb anchors as required to secure frames to adjacent construction, formed of not less than 16-gage galvanized steel.

   1. Masonry Construction: Adjustable, flat, corrugated, or perforated, t-shaped to suit frame size, with leg not less than 2 inches wide by 10 inches long. Furnish at least two (2) anchors per jamb up to 7 feet 6 inches in height; Three (3) anchors up to an 8 feet 0 inches in jamb height; one (1) additional anchor for each 24 inches or fraction thereof over 8 feet 0 inches in height.

   2. Metal Stud Partitions: Insert type with notched clip to engage metal stud, welded to back of frames. Provide at least three (3) anchors for each jamb for frames up to 7 feet 6 inches height; five (5) anchors up to 8 feet 0 inches in jamb height; one (1) additional anchor each 24 inches or fraction thereof over 8 feet 0 inches in height.

   3. In-Place Concrete or Masonry: Anchor frame jambs with minimum 3/8 inch concealed bolts into expansion shields or inserts at 6 inches from top and bottom and 26 inches on center, unless otherwise shown. Reinforce frames at anchor locations. Except for fire-rated openings, apply removable stop to cover anchor bolts unless otherwise indicated.

D. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of not less than 14-gage galvanized steel sheet, as follows:

   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions.

   2. Separate Topping Concrete Slabs: Adjustable type with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

E. Head Anchors: Provide two anchors at head of frames exceeding 42 inches wide for frames mounted in steel stud walls.

F. Head Strut Supports: Provide 3/8 inch by 2 inch vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members in compliance with UL 63.

G. Structural Reinforcing Members: Provide as part of frame assembly, where indicated at mullions, transoms, or other locations that are to be built into frame.

H. Head Reinforcing: For frames over 4 feet 0 inches wide in masonry wall openings, provide continuous steel channel or angle stiffener, not less than 12-gage for full width of opening, welded to back of frame at head. Lave vertical mullions in frames open at top for grouting.

I. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.

J. Rubber Door Silencers: Except on weather stripped doors, drill stop in strike jamb to receive three (3) silencers on single-door frames add drill head jamb stop to receive four (4) silencers on double-door frames. Install plastic plugs to keep holes clear during construction.

K. Plaster Guards: Provide 26-gage steel plaster guards or dust cover boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

L. Fire rated frames require metal applied label or embossed label indicating rating designation.

M. Electrified Openings: Doors shall be pre-wired with sufficient number of concealed wires to accommodate electric function of specified hardware. Provide Molex type standardized plug in connectors to accommodate up to twelve wires. Provide welded in place electric knock out box for field connection of ¾ inch conduit electrical contractor. Wire nuts are not acceptable.

2.7 STEEL FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP1, “Solvent Cleaning”; remove dirt, oil, grease, or other contaminants that could impair paint pond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 3, “Power Tool Cleaning,” or SSPC-SP 6/NACE No. 3, “Commercial Blast Cleaning.”

B. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).

C. Galvanized Steel Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc dust content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

D. Galvanized Steel Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).

E. Shop Primer: Manufacturer’s or fabricator’s standard, fast-curing, corrosion-inhibiting, lead and chromate-free, universal primer complying with ANSI A224.1 acceptance criteria; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

2.8 STAINLESS STEEL FINISHES

A. Finish designations prefixed by AISI conform with the system established by the American Iron and Steel Institute for designating finishes for stainless steel sheet.

B. Unless otherwise indicated, provide Bright, Directional Polish, AISI No. 4 finish on all stainless steel items.

1. On doors, align direction of polish marks to be vertical.

2. On frames, align direction of polish marks to be vertical on both jambs and head.

3. EXECUTION

2.9 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Install doors and frames per manufacturer’s requirements and SDI standards and instructions.

C. Install accessories in accordance with Shop Drawings, manufacturer’s data, and as herein specified.

1. Setting Masonry Anchorage Devices: Provide masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.

a. Set anchorage devices opposite each anchor location, in accordance with details on final Shop Drawings and anchorage device manufacturer’s instructions. Leave drilled holes rough, not reamed, and free from dust and debris.

2. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on final Shop Drawings.

D. Placing Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

1. At in-place concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.

2. Place frames at fire-rated openings in accordance with NFPA Standard No. 80.

3. Make field splices in frames as detailed on final Shop Drawings, welded and finished to match factory work.

4. Remove spreader bars only after frames or bucks have been properly set and secured.

E. Install doors after adjacent work is completed and dry. Do not install doors until closers or stops and holders can be installed simultaneously for protection of doors.

F. Fit non-fire rated doors accurately in their respective frames, with the following clearances:

1. Jambs and Head: 3/32 inch.

2. Meeting Edges, Pairs of Doors: 1/8 inch.

3. Bottom: 3/8 inch, where no threshold or carpet.

4. Bottom: 1/8 inch, at threshold or carpet.

G. Place fire-rated doors with clearances as specified in NFPA Standard No. 80.

2.10 ADJUST AND CLEAN

A. Final Adjustments: Check and readjust operating hardware items just prior to final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed or otherwise unacceptable.

B. Prime Coat Touch-Up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

  1. Repair installed dented and damaged units to new condition by filling with automotive body putty.

  2. Fill exposed countersunk anchor screws in countersunk screw holes with automotive body putty after units are installed in place.

  3. Grind puttied areas smooth, true and even with surrounding surfaces. Repaint puttied areas with one additional coat of the specified primer before proceeding with field painting.

END OF SECTION 08 11 13 00

SECTION 08 14 16 00 – FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Quality Standards: Comply with the following standards:

1. AWS Quality Standards: Edition 1, AWI with quality certification program; or WDMA Industry Standard IS-1A-11.

2. Fire Ratings Compliance: Fire-rated wood doors to comply with NEPA-80.

a. UL10B – Fire Tests for Door Assemblies- Neutral Pressure (neutral pressure plain is approx.. 40 inches above finish floor)

b. UL10C – Fire Tests for Door Assemblies – Positive pressure for Category “A” doors.

3. Regulatory Requirements: Comply with following

a. Fire Rated Label: Bear label of UL or other recognized fire-rating program acceptable to authorities having jurisdiction,

1) If any door or frame scheduled to be fire-rated cannot qualify for appropriate labeling because of its design, hardware, or any other reason, advise the University prior to submission of bids.

4. Sound rated doors, including test report indicating STC rating per ASTM E90 from test laboratory.

B. Obtain doors from a single manufacturer.

1.4 SUBMITTALS

A. Product Data:

1. Door manufacturer's product data for each type of door, including details of core and edge construction, trim for openings and louvers, and factory-finishing specifications.

2. Record Documents:

3. Shop Drawings: Submit Shop Drawings indicating location and size of each door, elevation of each kind of door, details of construction, location and extent of hardware blocking, fire ratings, requirements for factory finishing and other pertinent data. Include catalog cuts and descriptive data for glazing, sound gasketing, weather-stripping and thresholds to be used.

4. Door schedule: Submit manufacturers'; schedule, including door dimensions, cutouts, species, finish and hardware. Coordinate submittals with other doors, frames, and hardware and use the same "opening number identification" as given on the Drawings and the Door Schedule. Submittals not using the numbering identification system shown on Drawings and Schedules will be rejected.

5. Samples: Submit manufacturer's door finish samples, showing range of color variation.

6. Manufacturer's certification: Submit manufacturer's certification that doors comply with specified requirements and are suitable for intended application. Include information that manufacturer is in good standing with Window and Door Manufacturers Association (WDMA).

7. Environmental Documentation (when required on Drawings): Submit manufacturer's environmental documentation.

a. Forest Stewardship Council (FSC) Stave Lumber Core Construction: Chain on custody certificate.

b. Scientific Certification Systems (SCS) Particle Core Construction: Recovered fiber content certification.

c. Rapidly Renewable Materials – Agrifiber Core Construction: Product data.

d. Manufacturer's Information: Describe available LEED points.

8. Manufacturer's full lifetime warranty sample. Refer to Section 1.06 Warranty.

1.5 DELIVERY, STORAGE and HANDLING

A. Protect doors during transit, storage and handling to prevent damage, soiling and deterioration. Comply with requirements of referenced standards and recommendations of WDMA pamphlet "How to Store, Handle, Finish, Install, and Maintain Wood Doors", as well as with manufacturer's instructions.

B. Identify each door with individual opening numbers which correlate with designation system used on Shop Drawings for door, frames, and hardware, using temporary, removable or concealed markings.

C. Acceptance at Site: Inspected door system upon delivery. Replace damaged or defective materials before installation. Do not store in damp or wet areas. HVAC systems must be operating and balanced prior to arrival of doors. Acceptable humidity shall be no less than 25% or greater than 55%. Certain wood species are light sensitive. Protect doors from exposure to natural and artificial light after delivery. Temperature to be maintained between 60-99 F. Reference AWI quality standard including Section 100-S-3 "Moisture Content".

1. Field measure openings for door systems before start of fabrication.

1.6 WARRANTY

A. Warranties shall be in addition to, and not a limitation of, other rights The University may have under the Contract Documents.

B. Door Manufacturer's Warranty: Submit written agreement in door manufacturer's standard form signed by Manufacturer, Installer and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup or twist) or that show telegraphing of core construction in face veneers, or do not conform to tolerance limitations of referenced quality standards.

1. Warranty shall also include reinstallation which may be required due to repair or replacement of defective doors where defect was not apparent prior to hanging.

2. Warranty shall be in effect during the life of the installation.

3. Contractor's Responsibilities: Replace or refinish doors where Contractor's Work contributed to rejection or to voiding of manufacturer's warranty.

C. Special Warranty

1. Swinging Doors and Standard Closet Door Warranty: Provide one-year written warranty covering materials and installation for wood doors.

a. Include coverage hardware

b. Cover warping (bow, cup, or twist) photographing of construction below face veneers, tolerance limitations of WDMA I.S. 1-A

c. Cover delimitation

d. Glazing not included

e. Defects resulting from vandalism not included

2. Heavy Duty Closet Doors Warranty: Provide manufactures five-year written warranty covering materials and installation for bifold doors and sliding doors.

PART 2 - PRODUCTS

2.1 Manufacturers

1. Subject to compliance with requirements. Manufacturers offering products that may be incorporated in the work include:

a. Algoma

b. Mohawk

c. Haley

d. Graham

e. VT Industries

f. Hager

g. Or Approved Equal

2.2 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Fire rated doors: All required intumescent seals shall be concealed into the edge of the door: frame applied intumescent seals are not acceptable.

C. Electrified Openings: Doors shall be pre-wired with sufficient number of concealed wires to accommodate electric function of specified hardware. Provide Molex type standardized plug in connectors to accommodate up to twelve wires.

2.3 FLUSH SOLID CORE WOOD DOORS - GENERAL

A. Adhesive: Type II.

B. Face Panels: Manufacturer's standard 2 or 3-ply face panels.

C. Stiles: 1-1/16 inch to 1-½ inch wide, one or two ply closed grain, solid hardwood. Provide fire retardant treated, UL approved, one or two ply hardwood stiles at fire-rated doors.

D. For transparent finish doors, provide manufacturer's standard thickness face veneers per ANSI/WDMA I.S. 1A, Premium Grade.

1. Face Veneer: Plain Sliced Red Oak, unless noted otherwise. Book and Balance match for color and grain at veneer joints.

2. Vertical Edges: Same species, cut, and color as face veneer, no finger jointed material permitted.

3. Finish: Shop finished as specified herein.

4. Low Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

E. For paint finish doors provide manufacturer's standard thickness face veneer per ANSI/WDMA I.S.1A, Good Grade rotary cut Birch.

1. Finish: Pre-sanded on faces and all edges, ready for field finishing as part of the work of Section 09 91 00.

2. Thickness: 1 ¾” unless noted otherwise.

2.4 FIRE RATED (20 MINUTE) FLUSH solid core WOOD DOORS

A. Core: 5-ply bonded low density wood blocks, random lengths, kiln dried.

1. Bonding: Stiles and rails bonded to core, then entire unit abrasive planed before veneering.

2. Subject to compliance with requirements, provide manufacturer and product from one of the following:

3. VT Industries, Inc.

4. Or Approved equal

2.5 Fire rated flush solid core wood doors

A. Core: Incombustible mineral.

1. Provide fire retardant treated, UL approved 5 inch deep solid hard wood or Structural Composite Lumber top rail.

2. Provide fire retardant treated, UL approved lock block reinforcement where mortised hardware is scheduled.

3. Subject to compliance with requirements, provide manufacturer and product from one of the following:

4. VT Industries, Inc.

5. Or Approved equal

2.6 PLASTIC LAMINATE FACED solid core DOORS, GENERAL

A. AWI grade: Custom

B. Bond: type II water resistant.

C. Plastic Laminate Face Panels:

1. Low Pressure Decorative Laminate Faces:

a. Core: Particleboard type M-2 (42lbs-ft).

b. Color/Wood Pattern: as approved by The University.

1) Low-pressure decorative laminates faces shall be thermally fused to cores under heat and pressure, complying with Laminating Materials Association’s Product Standard and Typical Physical Properties of Decorative Overlays, LMA 2003.

2) Exposed edges shall be of an impact-resistant polymer edging, minimum .040” thick, applied to all four edges after faces; color or wood grain pattern shall be the same as the faces.

3) Provide doors with pilot holes factory-drilled for vertical edge hinges and lock sets.

c. Manufacturers of Low Pressure Decorative Laminate Faces:

1) Maiman Company: LPDL

2. High Pressure Decorative Laminate Faces

a. Particleboard type NEMA LD 2 (28lb-ft),

b. Color/Wood Pattern: as approved by The University.

1) Stiles and rails shall be bonded to the core, with the entire unity abrasive planed before faces and crossbands are applied.

2) Provide premium grade plastic-laminate faces with high-pressure decorative laminates complying with NEMA LD 2 (28lb-ft). Grade HGS.

D. Colors, Patterns, and Finishes: As selected by Architect

E. Stiles: 1 1/6 inch to 1 1/2 inch wide, one or two ply closed grain, solid hardwood; paint edge to match laminate faces. Provide fire retardant treated, UL approved, one or two ply hardwood stiles at fire-rated doors.

F.Rails:

1. Top Rail: 5 inch one to three ply closed grain, solid hardwood or Structural Composite Lumber.

2. Bottom Rail: Hardwood or Structural Composite Lumber. Provide 5 inch deep rail where concealed door seal or kick plate is scheduled.

3. Provide 5 inch fire retardant treated, UL approved hardwood or Structural Composite Lumber top rails at fire-rated doors.

4. Provide 5 inch fire retardant treated, UL approved hardwood or Structural Composite Lumber bottom rail at fire-rated doors where concealed door seal or kick plate is scheduled.

5. Blocking:

6. Provide lock block reinforcement where mortised hardware is scheduled.

7. Provide 5 inch hardwood or Structural Composite Lumber at intermediate-height where exit devices are scheduled.

8. Provide 5 inch fire retardant treated, UL approved hardwood or Structural Composite Lumber blocking at intermediate height at fire-rated doors

9. Low Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

2.7 FIRE RATED (20 MINUTE) FLUSH WOOD DOORS, PLASTIC LAMINATE FACED

A. Construction: Five plies. Mat formed wood particleboard core, complying with ANSI A 208.1, Grade LD-2.

1. Bonding: Stiles and rails bonded to core, with entire unit abrasive planed before faces and crossbands are applied.

2.8 FIRE RATED FLUSH WOOD DOORS, PLASTIC LAMINATE FACED

A. Construction: Incombustible non-asbestos mineral core.

1. Bonding: Stiles and rails bonded to core.

2. Treatment: Components shall be salt free.

2.9 LOUVERS AND LIGHT FRAMES

A. Metal Louvers: Size, type and profile shown and fabricated from the following:

1. Steel: 20-gage, galvanized and factory primed for paint finish.

2. Color: Match Building.

3. Metal Frames for Light Openings in Fire Doors: VLF-EZ by air louvers Inc. or approved equal. Refer to drawing for sizes.

2.10 pocket doors

A. Standard Sliding Pocket Door: Conforms to ANSI A156.14/ Type: 08671, D8701.

1. Provide complete manufacturer’s standard hardware, including track headers, guides, and pulls to provide complete operating sliding doors.

a. Doors: Solid core red oak veneer (1-3/8 inch) thick, unless otherwise indicated.

2.11 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Field measure all openings for door systems prior to fabrication. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

1. Comply with requirements in NFPA 80 for fire-rated doors.

2. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI-WDHS-3 series standards, and hardware templates.

3. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.

4. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

B. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.

1. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

C. Openings: Cut and trim openings through doors in factory.

1. Light Openings: Trim openings with moldings of material and profile indicated.

2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00 "Glazing."

2.12 SHOP PRIMING

A. Doors for Opaque Finish: Shop prime exposed portions of doors for paint finish with one (1) coat of wood primer specified in Division 09 section "Painting".

B. Transparent Finish: Shop seal faces and edges of doors for transparent finish with stain (if required) and other required pretreatments and first coat of finish as specified in Division 09.

2.13 FACTORY FINISHING

A. General: For transparent finish wood doors, perform finishing operation at the factory in compliance with referenced AWI quality standard including Section 1500 "Factory Finishing".

B. Transparent Finish: Comply with requirements indicated for grade, finish system, staining effect and sheen.

C. Stain to be Sherwin Williams, color selected by owner.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine installed door frames prior to hanging door:

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.

2. Reject doors with defects.

3. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Manufacturer's Instructions: Install wood doors to comply with manufacturer's instructions and of referenced AWI standard and as indicated.

1. Install fire rated doors in corresponding fire rated frames in accordance with requirements of NFPA No. 80.

2. Job Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.

3. Fitting Clearances for Non Rated Doors: Provide 1/8 inch at jambs and heads; 1/16 inch per leaf at meeting stiles for pairs of doors; and 1/8 inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide ¼ inch clearance from bottom of door to top of threshold.

4. Fitting Clearances for Fire Rated Doors: Complying with NFPA 80.

5. Bevel non rated doors 1/8 inch in 2 inches at lock and hinge edges.

6. Bevel fire rated doors 1/8inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

7. Factory-Fitted Doors: Fit to frames for uniform clearance at each edge.

C. Factory Finished Doors: Restore finish before installation, if fitting or machining is required at the Project Site.

3.3 ADJUSTING AND PROTECTION

A. Operation: Re-hang or replace doors which do not swing or operate freely.

B. Finished Doors: Refinish or replace doors damaged during installation.

C. Protect doors as recommended by door manufacturer to ensure that wood doors will be without damage or deterioration at time of Substantial Completion.

END OF SECTION 08 14 16 00

SECTION 08 31 13 00 – ACCESS DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Single-source Responsibility: Obtain access doors for entire Project from one source from a single manufacturer.

B. Fire-Resistance Ratings: Wherever access doors are required in construction where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in Underwriters Laboratories, Inc.'s "Building Materials Directory" for rating shown.

1. Provide UL label on each fire-rated access door.

2. Size Variations: Obtain Architect's acceptance of manufacturer's standard size units, which may vary slightly from sizes indicated.

C. Coordination: Furnish inserts and anchoring devices that must be built into other work for installation of access doors. Coordinate delivery with other work to avoid delay.

1.4 SUBMITTALS

A. Product Data:

1. Product data in form of manufacture's technical data and installation instructions for each type of access door assembly, including setting Drawings, templates, instructions, and directions for installation of anchorage devices.

   a. Include complete schedule, including types, general locations, sizes, wall and ceiling construction details, finishes, latching or locking provisions, and other data pertinent to installation.

B. Samples:

1. Samples, 3 inches by 5 inches minimum size, of each panel face material showing factory-finished color and texture.

2. Shop Drawings:
3. Show fabrication and installation of customized access doors and frames, including details of each frame type, elevations of door design types, anchorage and accessory items.

1.5 Project conditions

A. Verification: Obtain specific locations and sizes for required access doors from trades requiring access to concealed equipment, and indicate on submittal schedule.

B. Special-Size Access Doors: Use where required or requested; indicate on schedule.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. To establish standards of manufacturer, operation, performance, and appearance, Drawings and Specifications are based on products of Babcock Davis. Provided compliance with requirements, products of the following manufacturers will also be acceptable:

1. Babcock Davis
2. Or Approved Equal

2.3 MATERIALS AND FABRICATION

A. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts, and ready for installation.

B. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.

C. Frames: Fabricate from 16-gage steel.

D. Frames: Fabricate from 16-gage, #4 satin-finished stainless steel.

1. Fabricate frame with exposed flange nominal 1 inch wide around perimeter of frame for units installed in the following construction:
    a. Exposed masonry.
    b. Exposed concrete.
    c. Drywall finish.
    d. Ceramic tile finish.
    e. Wood paneling.
2. For gypsum drywall or gypsum veneer plaster, furnish perforated frames with drywall bead.
3. For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
4. For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

5. Flush Panel Doors: Fabricate from not less than 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees. Finish with manufacturer’s factory-applied prime paint.

E. Flush Panel Doors: Fabricate from not less than 14-gage stainless steel sheet, with concealed spring hinges or concealed piano hinge set to open 175 degrees. Buff exposed surface to #4 satin finish.

1. For fire-rated units, provide manufacture’s standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.

2. Recessed Panel Doors: Fabricate from not less than 18-gage sheet steel with face of panel formed to provide recess below surface of applied finish. Reinforce panel as required to proven buckling. Finish with manufacturer’s factory-applied prime paint.

3. Furnish recessed panels for concealed installation in acoustic tile ceiling systems.

4. Furnish recessed panels and frames with expanded metal lath for concealed installation in plaster.

5. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

6. Provide one (1) cylinder lock per access door. Furnish two (2) keys per lock. Key all locks alike, unless otherwise scheduled.

7. Where shown or scheduled, provide one (1) cylinder lock per access door. Furnish two (2) keys per lock. Key all locks alike unless otherwise indicated.

8. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Coordinate installation with work of other trades.

D. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.

3.2 ADJUST AND CLEAN

A. Adjust hardware and panels after installation for proper operation.

B. Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13 00

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SECTION 08 33 23 00 – OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Furnish each overhead coiling door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components.

   1. Furnish overhead coiling door units by one manufacturer for entire Project.

B. Insert and Anchorages: Furnish inserts and anchoring devices that must be set in concrete or built into masonry to install units. Provide setting drawings, templates, instructions, and directions to install anchorage devices. Coordinate delivery with other work to avoid delay.

   1. See concrete and masonry Sections of these Specifications regarding installation of inserts and anchorage devices.

C. Wind Loading: Design and reinforce overhead coiling doors to withstand a 20 psf (85 mph) wind loading pressure.

1.4 SUBMITTALS

A. Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

   1. Product Data: Submit manufacturer's product data, roughing in diagrams, and installation instructions for each type and size of overhead coiling door. Provide operating instructions and maintenance information, and complete information describing fire release system including electrical rough in instructions.

   2. Shop Drawings: Submit shop drawings for special components and installations which are not fully dimensioned or detailed on manufacturer’s data sheets.

   3. Label Certification: Submit UL certification for oversize fire rated doors and frames that each assembly has been constructed with materials and methods equivalent to requirements for labeled construction.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. Cornell

1.01.1.1.3 Overhead Door Company

B. Or approved Equal

2.3 FIRE RATED ROLLING SERVICE DOORS

A. Provide fire door assemblies which comply with NFPA No. 80 and have been fire tested, rated and labeled in accordance with ASTM E 152. Furnish each door with a metal UL label as evidence of rating, with label indicating rating in hours of duration of exposure to fire and letter designation of location for which assembly is designed.

1. Where fire door assemblies exceed size for which testing and labeling service is offered, furnish UL "Certificate of Inspection" for oversize doors, in lieu of label, certifying that design, materials and construction are equivalent to doors tested and labeled by UL.

B. Automatic Closing: Provide automatic closing device and governor, operating when activated by temperature rise and melting of 160 degrees F (71 degrees C) fusible link. Construct governor unit to be inoperative during normal door operations. Design release mechanism to reset easily.

1. Provide governor device in all automatic-closing doors to control rate of descent. Governor device shall be factory, or field, adjustable to set descent rate to the minimum (slowest) allowed by the requirements of NFPA 80.

C. Provide UL Listed time delay release device designed to delay closing of fire doors for 10 seconds after alarm signal or power loss: Overhead Door Corporation "Fire Sentinel Model B2".

1.01.1.1.4 Overhead Door Corporation "630 Series" interior face mounted, motor operated, steel rolling fire door.

D. Overhead Door Corporation "630 Series" interior face mounted, chain operated, steel rolling fire door.

1.01.1.1.5 Overhead Door Corporation "630 Series" interior face mounted, push up manually operated, steel rolling fire door.

E. Overhead Door Corporation "630 Series" between jamb mounted, chain operated, steel rolling fire door.

1.01.1.1.6 Overhead Door Corporation "630 Series" between jamb mounted, push up manually operated, steel rolling fire door.

F. Door Curtain: Type C275 interlocking slats, fabricated of 20-gage (minimum) phosphatized, zinc coated steel. Provide endlocks and bottom bar in accordance with UL requirements.

2.4 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtain: Fabricate overhead coiling door curtain of interlocking slats, designed to withstand required wind loading, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of material gage recommended by door manufacturer for size and type of door required, and as follows:

1. Steel Door Curtain Slats: Structural quality, cold rolled galvanized steel sheets complying with ASTM A 446, Grade A, with G90 zinc coating, complying with ASTM A 525.

B. Endlocks: Malleable iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets. Provide locks on alternate curtain slats for curtain alignment and resistance against lateral movement.

1.01.1.1.7 Windlocks: Malleable iron castings secured to curtain slats with galvanized rivets. Unless otherwise recommended by door manufacturer, provide windlocks on doors exceeding 16 feet wide. Space windlocks approximately 24 inches on center on both edges of curtain.

C. Bottom Bar: Consisting of two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick, either galvanized or stainless steel or aluminum extrusions to suit type of curtain slats.

1. Provide a replaceable gasket of flexible vinyl or neoprene between angles as a weather seal and cushion bumper for manually operated doors, unless shown as an overlapping joint.

D. Curtain Jamb Guides: Fabricate curtain jamb guides of steel angles, or channels and angles with sufficient depth and strength to retain curtain loading. Build up units with minimum 3/16 inch thick steel sections, galvanized after fabrication. Slot bolt holes for track adjustment.

1.01.1.1.8 Secure continuous wall angle to wall framing with a minimum of 3/8 inch bolts at not more than 30 inches on center., unless closer spacing recommended by door manufacturer. Extend wall angles above door opening head to support coil brackets, unless otherwise indicated. Place anchor bolts on exterior wall guides so they are concealed when door is in closed position. Provide removable stops on guides to prevent over travel of curtain and a continuous bar for holding windlocks.

E. Vision Panels: Provide vision panels in arrangement as indicated, consisting of 1/4 inch thick cast thermoplastic, methyl methacrylate flat glazing sheet with smooth mirror finish. Set panels in neoprene or vinyl glazing channel secured to curtain slats.

1.01.1.1.9 Weather Seals: Provide vinyl or neoprene weatherstripping for exterior exposed doors, except where otherwise indicated. At door heads, use 1/8 inch thick continuous sheet secured to inside of curtain coil hood. At door jambs, use 1/8 inch thick continuous strip secured to exterior side of jamb guide.

2.5 COUNTERBALANCING MECHANISM

A. Counterbalance doors by means of adjustable steel helical torsion spring, mounted around a steel shaft and in a spring barrel, and connected to door curtain with required barrel rings. Use grease sealed bearings or self lubricating graphite bearings for rotating members.

1.01.1.1.10 Counterbalance Barrel: Fabricate spring barrel of hot formed structural quality carbon steel, welded or seamless pipe, of sufficient diameter and wall thickness to support roll up of curtain without distortion of slats and to limit barrel deflection to not more than 0.03 inch per foot of span under full load.

B. Provide spring balance of one or more oil tempered, heat treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.

1.01.1.1.11 Fabricate torsion rod for counterbalance shaft of cold rolled steel in size required to hold fixed spring ends and carry torsional load.

C. Brackets: Provide mounting brackets of manufacturer's standard design, either cast iron or cold rolled steel plate with bell mouth guide groove for curtain.

1.01.1.1.12 Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head and act as weather seal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface mounted hoods and any portion of between jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.

1. Fabricate steel hoods for doors of not less than 0.0276 inch thick (24-gage) hot dip galvanized steel sheet with G 90 zinc coating, complying with ASTM A 525.

2. Furnish automatic drop baffle to guard against passage of smoke or flame.

3. Fabricate aluminum hoods for aluminum doors of Alloy 3003 or 5052 aluminum sheet not less than 0.032 inch thick, mill finish.

1.01.1.1.12.1 PRIME PAINTING

D. Shop clean and prime ferrous metal and galvanized surfaces, exposed and unexposed, except tightly joined and lubricated surfaces, with door manufacturer's standard rust inhibitive primer. Use primer that is compatible with finish painting.

2.6 MANUAL DOOR OPERATORS

A. Provide manual operators except where electric door operators are indicated. When not shown, provide chain hoist operator unit.

1.01.1.1.13 Manual Push Up Operation: Design counterbalance mechanism so that required lift or pull for door operation does not exceed 25 pounds.

1. Provide galvanized steel lifting handle and slide bolt lock on inside bottom bar.

B. Chain Hoist Operator: Provide manual chain hoist operator consisting of endless steel hand chain, chain pocket wheel and guard, and geared reduction unit with a maximum 35 pound pull for door operation. Furnish alloy steel hand chain with chain holder secured to operator guide.

1.01.1.1.14 Crank Hoist Operator: Provide crank hoist operator consisting of crank and crank gear box, steel crank drive shaft and gear reduction unit. Size gear to require no more than a 25 pound effort to turn crank. Fabricate gear box to completely enclose operating mechanism and be oil tight. Provide manufacturer's standard crank locking device.

2.7 ELECTRIC DOOR OPERATORS

A. Furnish electric door operator assembly of size and capacity recommended and provided by door manufacturer; complete with electric motor and factory prewired motor controls, gear reduction unit, solenoid operated brake, remote control stations, control devices, conduit and wiring from controls to motor and central stations, and accessories required for proper operation.

1.01.1.1.15 Provide hand crank operated disconnect or a mechanism for automatically engaging an operator and releasing brake for emergency manual operation. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

B. Design operator so that motor may be removed without disturbing limit switch adjustment and without affecting emergency auxiliary operator.

1.01.1.1.16 Door Operator Type: Provide wall or bracket mounted door operator units consisting of electric motor, worm gear drive from motor to reduction gear box, chain or worm gear drive from reduction box to gear wheel mounted on counterbalance shaft, and a disconnect release for manual operation. Provide motor and drive assembly of horsepower and design as determined by door manufacturer for size of door required.

C. Electric Motors: Provide high starting torque, reversible, Class A insulated electric motors with overload protection. Size motor to move door in either direction, from any position, at not less than 2/3 foot or more than 1 foot per second.

1. Coordinate wiring requirements and current characteristics of motors with building electrical system.

2. Furnish open drip proof type motor.

3. Furnish totally enclosed, nonventilated type motors, fitted with plugged drain, for exterior applications and where indicated.

D. Remote Control Station: Provide key-operated "sustained pressure" type switch labeled "Open" and "Close" with automatic spring-return to the center "Stop" position.

1.01.1.1.17 Remote Control Station: Provide momentary contact, three button control station with push button controls labeled "Open," "Close," and "Stop."

1. Provide interior units, full guarded, surface mounted, heavy duty, with general purpose NEMA Type 1 enclosure.

2. Provide exterior units, full guarded type, standard duty, surface mounted, weatherproof, NEMA Type 4 enclosure, key operated.

E. Automatic Reversing Control: Furnish each door with an automatic safety switch, extending the full width of door bottom, and located within neoprene or rubber astragal mounted to bottom door rail. Contact with switch before fully closing will immediately stop downward travel and reverse direction to fully opened position.

1. Connect to control circuit through retracting safety cord and reel, or self coiling cable.

2. Provide electrically actuated automatic bottom bar.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.18 All installation shall be in accordance with manufacturer’s published recommendations.

B. Comply with manufacturer's instructions and recommendations for installing door units, hardware, accessories, and other components.

1.01.1.1.19 Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports according to final shop drawings, manufacturer's instructions, and as specified.

1. Install fire rated doors to comply with NFPA 80.

C. After completing installation, including work by other trades, lubricate, test, and adjust doors to operate easily, free from warp, twist, or distortion.

1. Test door closing when activated by smoke detector fire release system. Reset door closing mechanism after successful test.

1.01.1.1.19.1 training

D. Train Owner's personnel on procedures and schedules related to door operation, servicing, preventive maintenance, and procedures for resetting closing devices after activation.

END OF SECTION 08 33 23 00

SECTION 08 35 13 13 – ACCORDIAN FOLDING DOORS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of material for folding doors. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Accordion folding doors.
      b. Panel folding doors.
      c. Bifold doors.
      d. Bifold mirror doors.
      e. Fire-rated folding doors.

C. Submittals
   1. Product Data: For each type of product indicated.
   2. Shop Drawings: Include plans, elevations, sections, details, attachments to other work.
      a. Fire-Release System: Describe system, including testing and resetting instructions.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Samples: For each exposed product and for each color and texture specified.
   4. Product Schedule: For folding doors. Use same designations indicated on Drawings.
   5. Product certificates.
   6. Maintenance data.

D. Quality Assurance
   1. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
   2. Fire-Rated Folding Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B, **as directed**.
      a. Oversize Fire-Rated Folding Doors: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   3. Project Conditions
      a. Environmental Limitations: Do not deliver or install folding doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
      b. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication

1.2 PRODUCTS

A. Accordion Folding Doors
   1. Wood Fold Series 240 or approved equal.
   2. General: Top-supported, horizontal-sliding, manually operated accordion folding doors, with chain controlling the spacing and extension of pantographic or X-type accordion folding frames. Inner

and outer covers are continuous surface facings that attach to and completely cover the folding frames and are pleated as the door is retracted.

3. Outer Covering: Of type indicated below, complying with indicated surface-burning characteristics; attached to door support frames in a concealed manner at sufficient intervals to prevent sagging and separation and to permit on-site removal and repair, with vertical seams located in valleys and material hemmed at top and bottom.
    a. Vinyl reinforced with woven backing weighing not less than 20 oz./linear yd. (567 g/m).
        1) Color, Texture, and Pattern: As selected from manufacturer's full range.
    b. Fabric weighing not less than 16 oz./linear yd. (496 g/m), treated to resist stains.
        1) Color, Texture, and Pattern: As selected from manufacturer's full range.
    c. Manufacturer's standard nonwoven carpet, needle punched with fused fibers to prevent unraveling.
        1) Color, Texture, and Pattern: As selected from manufacturer's full range.
4. Sweep Seals: Manufacturer's standard top and bottom sweep seals on both **OR** one, **as directred**, side(s).
5. Carriers: Four-wheel carriers at lead post and two-wheel carriers at intermediate spacing, as necessary for size and weight of partition, to ensure secure, easy, and quiet operation.
    a. Doors 96 Inches (2438 mm) High or Less: Nylon wheels on steel shafts.
    b. Doors More Than 96 Inches (2438 mm) High: Ball-bearing wheels with nylon tread and steel shafts.
6. Tracks: Manufacturer's standard metal track made of extruded aluminum or formed steel with factory-applied, corrosion-resistant finish. Limit track deflection, independent of structural supporting system, to no more than 80 percent of bottom clearance. Design and fabricate track to support accordion folding doors and enable their operation without damage to track, folding unit, or adjacent surfaces; complying with the following requirements:
    a. Head Trim: Prefinished wood molding for surface-mounted tracks.
    b. Center stop for center-opening partitions.
    c. Galvanized-steel sheet or aluminum subchannel for forming pocket for recessed suspension track.
    d. Metal ceiling contact guard to protect finished ceiling surface from damage by moving top sweep seals; with finish matching other exposed metal.
    e. Curved track sections with ceiling clips to accommodate configuration indicated.
    f. Glide switch to divert door to auxiliary track.
    g. Pivot switch to change track direction.
    h. Cross-track switch to allow one door to cross another.
7. Hardware: Manufacturer's standard heavy-duty, manually operated metal pulls and latches as follows:
    a. Finish: Clear-anodized aluminum **OR** Satin stainless steel **OR** Dull chromium-finish brass **OR** Dull chromium-finish steel, **as directed**.
    b. Latch: Operable from both **OR** one, **as directed**, side(s) of closed door with coin-slot release on opposite side, **as directed**.
    c. Lock: Manufacturer's standard key-operated cylinder lock, operable from both sides **OR** Manufacturer's standard key-operated cylinder lock, operable from one side; privacy lock on other side **OR** Deadlock to receive cylinder, operable from both sides. Refer to Division 08 Section "Door Hardware" for cylinder requirements **OR** Deadlock to receive cylinder, operable from both sides, **as directed**.
    d. Foot bolts on lead post where indicated. Secure to post to avoid interference with seals.
8. Jamb Molding: Manufacturer's standard wood or metal molding at closing jamb as required for light-tight jamb closure.
9. Lead Posts and Jamb Posts: Not less than 0.048-inch- (1.2-mm-) thick steel **OR** extruded aluminum, **as directed**, formed for rigidity and light seal at supporting construction.
    a. Nonferrous jamb strip for single-operating partitions to ensure tight closure by engaging rubber bumper on lead post.
10. Meeting Post: Fixed single jamb for single-stacked doors **OR** Center meeting post for center-opening doors, **as directed**.
11. Stacking: Tiebacks to maintain door in stacked position.

12. Stacking Configuration: Stack single doors at one end of opening **OR** center-opening doors at both ends of opening **OR** doors in pockets with hinged pocket doors, **as directed**.
13. Opening Size: As directed or as indicated on Drawings.

B. Panel Folding Doors
1. General: Top-supported, horizontal-sliding, manually operated panel folding doors, with panels joined by continuous hinge connectors for the full height of panels.
2. Core Material and Thickness: Manufacturer's standard.
3. Panel Width: 4-inch (100-mm) **OR** 5-inch (125-mm) **OR** 6-inch (150-mm) **OR** 8-inch (200-mm), **as directed**, nominal width.
4. Panel Facing: Facings that comply with indicated surface-burning characteristics.
    a. Vinyl Facing: Vinyl not less than 7 mils (0.175 mm) thick, factory bonded to core.
        1) Color and Texture: As selected from manufacturer's full range.
    b. Vinyl Facing with Woven Backing: Vinyl reinforced with woven backing weighing not less than 12 oz./linear yd. (372 g/m), factory bonded to core.
        1) Color and Texture: As selected from manufacturer's full range.
    c. Plastic-Laminate Facing: Grade VGS, high-pressure plastic laminate complying with NEMA LD 3; adhesive applied under pressure to core.
        1) Color, Texture, and Pattern: As selected from manufacturer's full range.
    d. Wood-Veneer Facing: as approved by UT Health, wood veneer, laminated to core, with manufacturer's standard clear **OR** stained, **as directed**, transparent finish.
        1) Stain Color: As selected from manufacturer's full range.
5. Carriers: Four-wheel carriers at lead post and two-wheel carriers at intermediate spacing, as necessary for size and weight of partition, to ensure secure, easy, and quiet operation.
    a. Panels 5 Inches (125 mm) Wide or Less: Nylon wheels and axles.
    b. Panels More Than 5 Inches (125 mm) Wide: Ball-bearing wheels with nylon tread and steel shafts.
6. Tracks: Manufacturer's standard surface-mounted **OR** recessed, **as directed**, extruded-aluminum or steel track with factory-applied, corrosion-resistant finish. Limit track deflection, independent of structural supporting system, to no more than 80 percent of bottom clearance. Design and fabricate track to support operation without damage to track, folding unit, or adjacent surfaces; complying with the following requirements:
    a. Prefinished ceiling guard/channel for recessed tracks.
    b. Center stop for biparting partitions.
    c. Galvanized-steel sheet or aluminum subchannel for forming pocket for recessed suspension track.
    d. Nonferrous jamb strip for single-operating partitions to ensure tight closure by engaging rubber bumper on lead post.
    e. Curved track sections to accommodate configuration indicated.
    f. Glide switch to divert door to auxiliary track.
    g. Pivot switch to change track direction.
    h. Cross-track switch to allow one door to cross another.
7. Hinge Connector: Manufacturer's standard extruded-vinyl hinge connector.
    a. Color: As selected from manufacturer's full range **OR** Match or coordinate with facing color, **as directed**.
8. Hardware: Manufacturer's standard heavy-duty, manually operated metal pulls and latches as follows:
    a. Finish: Clear-anodized aluminum **OR** Satin stainless steel **OR** Dull chromium-finish brass **OR** Dull chromium-finish steel, **as directed**.
    b. Latch: Operable from both **OR** one, **as directed**, side(s) of closed door.
    c. Lock: Manufacturer's standard key-operated cylinder lock, operable from both sides **OR** Manufacturer's standard key-operated cylinder lock, operable from one side; privacy lock on other side **OR** Deadlock to receive cylinder, operable from both sides. Refer to Division 08 Section "Door Hardware" for cylinder requirements **OR** Deadlock to receive cylinder, operable from both sides, **as directed**.
    d. Foot bolts on lead post where indicated. Secure to post to avoid interference with seals.

9. Jamb Molding: Manufacturer's standard wood or metal molding at closing jamb as required for light-tight jamb closure.
    a. Wood: Match species and finish of panel facing.
    b. Metal: Manufacturer's standard finish.
10. Wood Track Molding: Manufacturer's standard wood molding on each side of surface-mounted track to match species and finish of panel facings. Install with tight, hairline joints with all fasteners concealed.
11. Meeting Post: Fixed single jamb for single-stacked doors **OR** Center meeting post for biparting doors, **as directed**.
12. Stacking: Tiebacks to maintain door in stacked position.

C. Pocket Door:
    a. 1 3/8” solid core red oak veneer door
    b. Pocket door kit #9630 by Hager Co. or approved equal
    c. Pocket door pull # 330L by Hager Co. US260 finish or approved equal
    d. Custom WD. Frame with 2” trim refer to drawings for additional details

1.3 EXECUTION

A. Preparation
1. For folding doors supported by or anchored to permanent construction, advise installers of specific requirements for placement of anchorage devices. Furnish installers of other work with templates and drawings showing locations of anchorage devices and similar items.
2. In path of fire-rated folding doors, level floor with header to tolerance of plus or minus 1/16 inch (1.6 mm) across opening; grind or fill floor as necessary.

B. Installation
1. General: Install folding doors complying with manufacturer's written installation instructions. Install track in one piece.
    a. Comply with NFPA 80 for installing fire-rated folding doors.
2. Standard Floor Clearances: 1/4 to 3/4 inch (6.4 to 19 mm) maximum (above floor finish).
    a. Comply with NFPA 80 for clearances required for fire-rated folding doors.
3. Coordinate provisions for electrical service, sensing devices, and final connections for fire-rated folding doors.

C. Adjusting
1. Adjust units as necessary to ensure smooth, quiet operation without warping or binding. Adjust hardware to function smoothly. Confirm that latches engage accurately and securely without forcing or binding.
    a. Fire-Rated Folding Doors: Verify that all operations are functional and comply with requirements of authorities having jurisdiction.
2. Pocket Doors: Adjust to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly. Confirm that latches and locks engage accurately and securely without forcing or binding.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-rated folding doors.

END OF SECTION 08 35 13 13

SECTION 08 41 13 00 – ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 Summary

A. Provide aluminum entrance and storefront assemblies that comply with performance characteristics specified, as demonstrated by testing the manufacturer's corresponding stock assemblies according to test methods indicated.

B. Thermal Movement: Design the aluminum entrance and storefront framing systems to provide for expansion and Contraction of the component materials. Entrance doors shall function normally over the specified temperature range.

1. The system shall be capable of withstanding a metal surface temperature range of 180 degrees F (100 degrees C) without buckling, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, stress on glass, or other detrimental effects.

1.01.1.1.1.1 Wind Loads: Provide entrance and storefront systems, including anchorage, capable of withstanding windload design pressures calculated according to requirements of authorities having jurisdiction or the American Society of Civil Engineers' ASCE 7, Section 6.5, “Method 2- Analytical Procedure.”

2. Deflection of framing members in a direction normal to wall plane is limited to 1/175 of clear span or 3/4 inch (19 mm), whichever is smaller, unless otherwise indicated.

3. Static-Pressure Test Performance: Provide entrance and storefront systems that do not evidence material failures, structural distress, failure of operating components to function normally, or permanent deformation of main framing members exceeding 0.2 percent of clear span when tested according to ASTM E 330.

   a. Test Pressure: 150 percent of inward and outward wind-load design pressures.

   b. Duration: As required by design wind velocity; fastest 1 mile (1.609 km) of wind for relevant exposure category.

C. Hurricane-Resistance Test Performance: Provide entrance and storefront systems that pass large and small missile-impact tests, as required by systems' location above grade, and cyclic-pressure tests according to testing requirements of authorities having jurisdiction.

D. Dead Loads: Provide entrance- and storefront-system members that do not deflect an amount which will reduce glazing bite below 75 percent of design dimensions when carrying full dead load.

1. Provide a minimum 1/8 inch (3.18-mm) clearance between members and top of glazing or other fixed part immediately below.

2. Provide a minimum 1/16 inch (1.59-mm) clearance between members and operable windows and doors.

1.01.1.1.1.2 Live Loads: Provide entrance and storefront systems, including anchorage, that accommodate the supporting structures' deflection from uniformly distributed and concentrated live loads indicated without failure of materials or permanent deformation.

E. Air Infiltration: Provide entrance and storefront systems with permanent resistance to air leakage through fixed glazing and frame areas of not more than 0.06 cfm/sq. ft. (0.3 L/s/sq. m) of fixed wall area when tested according to ASTM E 283 at a static-air-pressure differential of 6.24 psf (30Pa).

F. Water Penetration: Provide entrance and storefront systems that do not evidence water leakage through fixed glazing and frame areas when tested according to ASTM E 331 at minimum differential pressure of 20 percent of inward-acting wind-load design pressure as defined by ASCE 7 “Method 2-Analytical Procedure”, but not less than 6.24 lbf/sq. ft (300 Pa). There shall be no leakage at minimum static air pressure differential of 8psf(383Pa) as defined in AAMA 501. Water leakage is defined as follows:

1. Uncontrolled water infiltrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.

1.01.1.1.1.3 Thermal Movements: Provide entrance and storefront systems, including anchorage, that accommodate thermal movements of systems and supporting elements resulting from the following maximum change (range) in ambient and surface temperature without buckling, damaging stresses on glazing, failure of joint sealants, damaging loads on fasteners, failure of doors or other operating units to function properly, and other detrimental effects.

2. Temperature Change (Range): 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

1.01.1.1.1.4 Structural-Support Movement: Provide entrance and storefront systems that accommodate structural movement including, but not limited to, sway and deflection.

G. Condensation Resistance: Where framing systems are "thermal-break" construction, provide units tested for thermal performance in accordance with AAMA 1503 showing condensation resistance factor (CRF) is not less than 45.

H. Thermal Transmittance: Provide framing systems that have an overall U-value of not more than 0.65 BTU/(hr. x sq. ft. x degrees F) at 15 mph exterior wind velocity when tested in accordance with AAMA 1503.

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all applicable references.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed installations of aluminum storefront and entrances similar in design and extent to those required for the Project and whose Work has resulted in construction with a record of successful in service performance.

B. Manufacturer's Qualifications: Provide aluminum entrances and storefront systems produced by a firm experienced in manufacturing systems that are similar to those indicated for this project and that have a record of successful in service performance.

C. Fabricator Qualifications: Provide aluminum entrances and storefront systems fabricated by a firm experienced in producing systems that are similar to those indicated for this Project, and that have a record of successful in service performance. The fabricator shall have sufficient production capacity to produce components required without causing delay in progress of the Work.

D. Single Source Responsibility: Obtain aluminum entrance and storefront systems from one (1) source and from a single manufacturer.

E. Design Criteria: The Drawings indicate the size, profile, and dimensional requirements of aluminum entrance and storefront Work required and are based on the specific types and models indicated. Aluminum entrance and storefront by other manufacturers may be considered, provided deviations in dimensions and profiles are minor and do not change the design concept as judged by the Architect. The burden of proof of equality is on the proposer.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic affects and set quality standards for materials and execution.

   1. Build mockup for types of storefront elevations in indicated. In locations shown on Drawings.

1.01.1.1.1.5 Structural-Sealant Glazing: Comply with ASTM C 1401, “Guide of Structural Sealant Glazing” for design and installation of structural glazed systems.

G. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.

1.5 SUBMITTALS

A. Product Data:

   1. Product data for each aluminum entrance and storefront system required, including:

      a. Manufacturer's standard details and fabrication methods.

      b. Data on finishing, hardware and accessories.

      c. Recommendations for maintenance and cleaning of exterior surfaces.

B. Record Documents:

   1. Shop Drawings for each aluminum entrance and storefront system required, including:

      a. Layout and installation details, including relationship to adjacent Work.

      b. Elevations at 1/4 inch scale.

      c. Detail sections of typical composite members.

      d. Anchors and reinforcement.

      e. Hardware mounting heights.

      f. Provisions for expansion and Contraction.

      g. Glazing details.

   2. Hardware Schedule: Submit complete hardware schedule organized into sets based on hardware specified. Coordinate hardware with doors, frames, and related Work to ensure proper size, thickness, hand, function, and finish. Include item name, name of the manufacturer and complete designations of every item required for each door opening.

3. Samples for Initial Color Selection: Submit pairs of samples of each specified color and finish on 12 inch long sections of extrusions or formed shapes. Where normal color variations are anticipated, include two (2) or more units in each set of samples indicating extreme limits of color variations. Include samples of hardware and accessories involving color selection.

4. Samples for Verification Purposes: The Architect reserves the right to require additional samples, that show fabrication techniques and workmanship, and design of hardware and accessories.

5. Fabrication Sample: Of each vertical to horizontal intersection of aluminum-framed systems, made from 12” lengths of full-size components and showing details of the followings

    a. Joinery, including concealed welds.

    b. Anchorage.

    c. Expansion provisions.

    d. Glazing.

    e. Flashing and drainage.

6. Test Reports: Provide certified test reports from a qualified independent testing laboratory showing that aluminum entrance and storefront systems have been tested in accordance with specified test procedures and comply with performance characteristics indicated.

1.6 DELIVERY, STORAGE and HANDLING

A. Deliver aluminum entrance and storefront components in the manufacturer's original protective packaging.

B. Store aluminum components in a clean weather-tight, dry location away from uncured masonry or concrete. Cover components with waterproof paper, tarpaulin or polyethylene sheeting in a manner to permit circulation of air.

    1. Stack framing components in a manner that will prevent bending and avoid significant or permanent damage.

1.7 Project conditions

A. Field Measurements: Check openings by accurate field measurement before fabrication. Show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delay of the Work.

    1. Where necessary, proceed with fabrication without field measurements, and coordinate fabrication tolerances to ensure proper fit.

1.8 warranty

A. Submit a written warranty, executed by the manufacturer, agreeing to repair or replace units that fail in materials or workmanship within the specified warranty period. Failures include, but are not necessarily limited to:

    1. Structural failures including excessive deflection, excessive leakage or air infiltration.

    2. Faulty operation.

    3. Deterioration of metals, metal finishes and other materials beyond normal weathering.

1.01.1.1.1.6 Warranty Period: Two (2) years after the date of Substantial Completion.

B. The warranty shall not deprive The University of other rights or remedies The University may have under other provisions of the Contract Documents, and is in addition to and runs concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. Specifications are based on Kawneer Company "Tri-Fab VG '450' Framing System". Subject to compliance with requirements, products of the following will also be acceptable:

1. EFCO Corporation.
2. Pittco Architectural Metals.
3. U.S. Aluminum.
4. Vistawall Architectural Products.
5. Or Approved Equal.

2.3 MATERIALS

A. Aluminum Members: Alloy and temper recommended by the manufacturer for strength, corrosion resistance, and application of required finish; comply with ASTM B 221 for aluminum extrusions, ASTM B 209 for aluminum sheet or plate, and ASTM B 211 for aluminum bars, rods and wire.

B. Carbon steel reinforcement of aluminum framing members shall comply with ASTM A 36 for structural shapes, plates and bars, ASTM A 611 for cold rolled sheet and strip, or ASTM A 570 for hot rolled sheet and strip.

C. Glass and Glazing Materials: Comply with requirements of "Glass and Glazing" Section of these Specifications.

D. Glazing Gaskets: Manufacturer's standard pressure-glazing system of black, resilient glazing gaskets, setting blocks, and shims or spacers, fabricated from an elastomer of type and in hardness recommended by system and gasket manufacturer to comply with system performance requirements. Provide gasket assemblies that have corners sealed with sealant recommended by gasket manufacturer.

E. Spacers, Setting Blocks, Gaskets, and Bond Breakers: Manufacturer's standard permanent, nonmigrating types in hardness recommended by manufacturer, compatible with sealants, and suitable for system performance requirements.

F. Structural Silicone Sealant: Type recommended by sealant and system manufacturers that complies with ASTM C 1184 requirements, is compatible with system components with which it comes in contact, and is specifically formulated and tested for use as a structural sealant.

1. Color: As selected by Architect from manufacturer's full range of colors.
2. Tensile Strength: 100 psi (689.5 kPa) minimum.
3. Provide sealant with modules of elasticity that will not allow movement of more than 25 percent of joint width, unless less movement is required by structural-sealant-glazed systems' design.

4. Use neutral-cure silicone sealant with insulating-glass units.

1.01.1.1.1.7 Secondary Sealant: For use as weatherseal, compatible with structural silicone sealant and other system components with which it comes in contact, and that accommodates a 50 percent increase or decrease in joint width at the time of application when measured according to ASTM C 719.

5. Color: As selected by Architect from manufacturer's full range of colors.

6. Use neutral-cure silicone sealant with insulating-glass units.

1.01.1.1.1.8 Panel Core Material: Resin impregnated Kraft paper honeycomb.

G. Panel Core Material: Rigid, closed cell polyurethane insulation.

H. Panel Core Material: Rigid, noncombustible mineral insulation board.

I. Fasteners: Provide fasteners of aluminum, nonmagnetic stainless steel, zinc plated steel, or other material warranted by the manufacturer to be noncorrosive and compatible with aluminum components, hardware, anchors and other components.

   1. Reinforcement: Where fasteners screw anchor into aluminum members less than 0.125 inches thick, reinforce the interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard noncorrosive pressed in splined grommet nuts.

   2. Exposed Fasteners: Do not use exposed fasteners except for application of hardware. For application of hardware, use Phillips flat head machine screws that match the finish of member or hardware being fastened.

1.01.1.1.1.9 Concealed Flashing: 0.0179 inch (26-gage) minimum dead soft stainless steel, or 0.026 inch thick minimum extruded aluminum of alloy and type selected by manufacturer for compatibility with other components.

J. Brackets and Reinforcements: Provide high strength aluminum brackets and reinforcements; where use of aluminum is not feasible provide nonmagnetic stainless steel or hot dip galvanized steel complying with ASTM A 123.

K. Concrete and Masonry Inserts: Provide cast iron, malleable iron, or hot dip galvanized steel inserts complying with ASTM A 123.

L. Compression Weatherstripping: Manufacturer's standard replaceable compressible weatherstripping gaskets of molded neoprene complying with ASTM D 2000 or molded PVC complying with ASTM D 2287.

M. Sliding Weatherstripping: Manufacturer's standard replaceable weatherstripping of wool, polypropylene, or nylon woven pile, with nylon fabric or aluminum strip backing, complying with AAMA 701.2.

2.4 hardware

A. Refer to Specification Section 08 71 00 00 “Door Hardware.

2.5 components

A. Storefront Framing System: Provide storefront and entrance framing systems fabricated from extruded aluminum members of size and profile indicated. Include subframes and other reinforcing members of the type indicated. Provide for flush glazing storefront from the exterior on all sides without projecting stops. Shop fabricates and preassembles frame components where possible. Provide storefront frame sections without exposed seams.

1. Mullion Configurations: Provide pockets at the inside glazing face to receive resilient elastomeric glazing. Mullions and horizontals shall be one (1) piece. Make provisions to drain moisture accumulation to the exterior. Make accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearance.

2. Infill Panels: Provide flush laminated infill panels of thickness indicated, fabricated with panel core material laminated with waterproof glue between two (2) sheets of aluminum.

1.01.1.1.1.10 Entrance Door Frames: Provide tubular and channel frame entrance door frame assemblies, as indicated, with welded or mechanical joints in accordance with manufacturer's standards. Reinforce as necessary to support required loads.

B. Stile and Rail Type Entrance Doors: Provide tubular frame members, fabricated with mechanical joints using heavy inserted reinforcing plates and concealed tie rods or j bolts.

   1. Glazing: Fabricate doors to facilitate replacement of glass or panels, without disassembly of stiles and rails. Provide snap on extruded aluminum glazing stops, with exterior stops anchored for non-removal.

   2. Design: Provide 1-3/4 inch thick doors of design indicated.

      a. Thin stile (less than 1-3/4 inches wide).

      b. Narrow stile (2 inch nominal width).

      c. Medium stile (3-1/2 inch nominal width).

      d. Wide stile (over 4 inches wide).

      e. Center panel (door glazed with 2 or 3 lights).

   3. At perimeter and main exterior public openings use aluminum framed, wide stile 4 ½” minimum glass doors. Tempered shatter-resistant glass.

   4. Weather-stripping: Replaceable wool pile continuous in head, jambs, bottom, and meeting rails at exterior doors and frames, in meeting rails at interior.

1.01.1.1.1.11 Flush Panel Type Aluminum Doors: Provide flush panel type doors fabricated with tubular frame members with reinforced mechanical or welded joints; limit frame exposure to 3/4 inch maximum width on door faces. Provide minimum 0.064 inch thick aluminum face sheets, mechanically interlocked with frame members or laminated to panel core material and framing with waterproof glue.

   5. Design: Provide 1-3/4 inch thick doors of design indicated.

   6. Lights: Provide glazed openings as indicated, with aluminum moldings and stops. Provide non-removable stops on the exterior.

2.6 fabrications

A. Fabricate aluminum entrance and storefront components to designs, sizes and thicknesses indicated and to comply with indicated standards. Sizes and profile requirements are indicated on the Drawings. Variable dimensions are indicated, with maximum and minimum dimensions required, to achieve design requirements and coordination with other Work.

   1. Thermal Break Construction: Fabricate storefront framing system with an integrally concealed, low conductance thermal barrier, located between exterior materials and exposed interior members to eliminate direct metal to metal contact. Use manufacturer's standard construction that has been in use for similar projects for period of not less than three (3) years.

1.01.1.1.1.12 Prefabrication: Complete fabrication, assembly, finishing, hardware application, and other work to the greatest extent possible before shipment to the Project Site. Disassemble components only as necessary for shipment and installation.

2. Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work to prevent damage to exposed finish surfaces. Complete these operations for hardware prior to application of finishes.

3. Do not drill and tap for surface mounted hardware items until time of installation at Project Site.

4. Pre-glaze door and frame units to greatest extent possible.

1.01.1.1.1.13 Welding: Comply with AWS recommendations. Grind exposed welds smooth to remove weld spatter and welding oxides. Restore mechanical finish.

5. Welding behind finished surfaces shall be performed in such a manner as to minimize distortion and discoloration on the finished surface.

1.01.1.1.1.14 Reinforcing: Install reinforcing as required for hardware and as necessary for performance requirements, sag resistance and rigidity.

B. Dissimilar Metals: Separate dissimilar metals with bituminous paint, or a suitable sealant, or a nonabsorptive plastic or elastomeric tape, or a gasket between the surfaces. Do not use coatings containing lead.

C. Continuity: Maintain accurate relation of planes and angles with hairline fit of contacting members.

1. Uniformity of Metal Finish: Abutting extruded aluminum members shall not have an integral color or texture variation greater than half the range indicated in the sample pair submittal.

1.01.1.1.1.15 Fasteners: Conceal fasteners wherever possible.

D. Weatherstripping: For exterior doors, provide compression weatherstripping against fixed stops. At other edges, provide sliding weatherstripping retained in adjustable strip mortised into door edge.

1. Provide EPDM or vinyl blade gasket weatherstripping in bottom door rail, adjustable for contact with threshold.

2. At interior doors and other locations without weatherstripping, provide neoprene silencers on stops to prevent metal to metal contact.

1.01.1.1.1.16 Provide finger guards of collapsible neoprene or PVC gasketing securely anchored into frame at hinge jamb of center pivoted doors.

2.7 finishes

A. Comply with NAAMM AMP 500 Series "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

B. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.

C. Finish aluminum entrance and storefront to match other adjacent glazed aluminum curtain wall components. Refer to "Glazed Aluminum Curtain Wall" Section for finish requirements.

D. Class II Clear Anodized Finish: AA M12C22A31 (Mechanical Finish: As fabricated, nonspecular; Chemical Finish: Etched, medium matte; Anodic Coating: Class II Architectural, clear film thicker than 0.4 mil).

E. Class I Clear Anodized Finish: AA M12C22A41 (Mechanical Finish: As fabricated, nonspecular; Chemical Finish: Etched, medium matte; Anodic Coating: Class I Architectural, clear film thicker than 0.7 mil) complying with AAMA 607.1.

F. Class I Color Anodized Finish: AA M12C22A42/A44 (Mechanical Finish: As fabricated, nonspecular; Chemical Finish: Etched, medium matte; Anodic Coating: Class I Architectural, film thicker than 0.7 mil with integral color or electrolytically deposited color) complying with AAMA 606.1 or AAMA 608.1.

1. Color: As selected by Architect from within standard industry colors and color density range.

1.01.1.1.1.17 Baked Enamel Finish: AA C12C42R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Chemical conversion coating, acid chromate fluoride phosphate pretreatment; Organic Coating: As specified below). Apply baked enamel in compliance with paint manufacturer's Specifications for cleaning, conversion coating, and painting.

2. Organic Coating: Thermosetting modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with minimum dry film thickness of 1.5 mils, medium gloss.

3. Color: As selected by Architect from manufacturer's standard colors.

1.01.1.1.1.18 High Performance Organic Coating: AA C12C42R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Chemical conversion coating, acid chromate fluoride phosphate pretreatment; Organic Coating: As specified below). Prepare, pre-treat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.

4. Fluorocarbon 2 Coat Coating System: Manufacturer's standard two (2) coat thermo cured system, composed of specially formulated inhibitive primer and fluorocarbon color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; comply with AAMA 605.2.

5. Fluorocarbon 3 Coat Coating System: Manufacturer's standard three (3) coat thermo cured system, composed of specially formulated inhibitive primer and fluorocarbon color coat, and clear fluorocarbon topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; comply with AAMA 605.2.

6. Color and Gloss: As selected by Architect from manufacturer's standard colors and gloss.

1.01.1.1.1.19 Stainless Steel Trim: Provide custom-designed snap-on extrusions for exterior mullion framing in design indicated. Provide exposed surfaces with ASTM A167-92b, Type 316 stainless steel with a No. 4 polished finish. Make bends in stainless steel with a maximum radius of 1/32 inch at all corners. Protect dissimilar metals from galvanic action by coating meeting surfaces with bituminous paint or other method.

7. Stainless steel cladding for doors will not be accepted.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine substrates and supports, with the Installer present, for compliance with requirements indicated, installation tolerances, and other conditions that affect installation of aluminum entrances and storefronts. Correct unsatisfactory conditions before proceeding with the installation.

B. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Set units plumb, level, and true to line, without warp or rack of framing members, doors, or. Panels, or impeding thermal movement. Install components in proper alignment and relation to established lines and grades indicated. Provide proper support and anchor securely in place.

D. Construction Tolerances: Install aluminum entrance and storefront to comply with the following tolerances:

1. Variation from Plane: Do not exceed 1/8 inch in 12 feet of length or 1/4 inch in any total length.

2. Offset from Alignment: The maximum offset from true alignment between two (2) identical members abutting end to end in line shall not exceed 1/16 inch.

3. Diagonal Measurements: The maximum difference in diagonal measurements shall not exceed 1/8 inch.

4. Offset at Corners: The maximum out of plane offset of framing at corners shall not exceed 1/32 inch.

1.01.1.1.1.20 Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

5. Zinc or cadmium plate steel anchors and other unexposed fasteners after fabrication.

6. Paint dissimilar metals where drainage from them passes over aluminum.

7. Paint aluminum surfaces in contact with mortar, concrete or other masonry with alkali resistant coating.

8. Paint wood and similar absorptive material in contact with aluminum and exposed to the elements or otherwise subject to wetting, with two (2) coats of aluminum house paint. Seal joints between the materials with sealant.

1.01.1.1.1.21 Drill and tap frames and doors and apply surface mounted hardware items. Comply with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.

E. Set sill members and other members in bed of sealant as indicated, or with joint fillers or gaskets as indicated to provide weather tight construction. Comply with requirements of Division 07 for sealants, fillers, and gaskets.

F. Refer to "Glass and Glazing" Section of Division 08 for installation of glass and other panels indicated to be glazed into doors and framing, and not pre-glazed by manufacturer.

G. Install aluminum framed storefront system and components to drain condensation, water penetrating, joints, and moisture migrating within aluminum framed storefront system to the exterior.

3.3 field quality control

A. Field Tests: Architect shall select storefront units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter caulked and cured. Conduct tests for air infiltration and water penetration with manufacturer's representative present. Tests not meeting specified performance requirements and units having deficiencies shall be corrected as part of the contract amount.

1. Testing: Testing shall be performed by a qualified independent testing agency. Refer to Testing Section for payment of testing and testing requirements. Testing Standard per AAMA 503, including reference to ASTM E 783 for Air Infiltration Test and ASTM E 1105 Water Infiltration Test.

   a. Air infiltration Tests: Conduct tests in accordance with ASTM E783. Allowable air infiltration shall not exceed 1.5times the amount indicated in the performance requirements or 0.09 cfm/ft2, whichever is greater.

   b. Water Infiltration Tests: Conduct tests in accordance with ASTM E 1105. No uncontrolled water leakage s permitted when tested at a static test pressure of two-thirds the specified water penetration pressure but not less than 6.24 psf (300 Pa).

B. Manufacturer’s Field Services: Upon Owners written request, provide periodic site visit by manufacturer’s field service representative.

C. Aluminum-Framed

3.4 ADJUSTING, cleaning and protection

A. Adjust operating hardware to function properly, for smooth operation without binding, and for weathertight closure.

B. Clean the completed aluminum framed system, inside and out, promptly after installation, exercising care to avoid damage to coatings. Remove excess sealant compounds, dirt and other substances from aluminum surfaces.

C. Clean glass surfaces after installation, complying with requirements from glass manufacturer’s written recommendations and from those contained in the "Glass and Glazing" Section for cleaning and maintenance. Remove excess glazing and sealant compounds, dirt and other substances from aluminum surfaces.

D. Institute protective measures required throughout the remainder of the construction period to ensure that aluminum entrances and storefronts will be without damage or deterioration, other than normal weathering, at time of acceptance.

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SECTION 08 81 00 00 – GLASS GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 definitions

A. Manufacturer is used in this Section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.

B. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's directions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

C. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's directions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated glass standard.

D. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use due to causes other than glass breakage and practices for maintenance and cleaning insulted glass contrary to manufactures directions. Evidence of failure is the obstruction of vision by dust, moisture, or film on the interior surfaces of glass. Improper practices for maintaining and cleaning glass do not comply with the manufacturer's directions.

1.4 QUALITY ASSURANCE

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. FGMA Publications: "FGMA Glazing Manual."
2. AAMA Publications: AAMA TIR A7 "Sloped Glazing Guidelines" and "Glass Design for Sloped Glazing."
3. LSGA Publications: "LSGA Design Guide."
4. SIGMA Publications: TM 3000 "Vertical Glazing Guidelines" and TB 3001 "Sloped Glazing Guidelines."

5. For Insulating Glass: Sigma TM-3000 IGMA

6. For Laminated Glazing: GANA

B. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.

   1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.

C. Fire Resistive Glazing Products for Door Assemblies: Products identical to those tested per ASTM E 152, labeled and listed by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

D. Fire Resistive Glazing Products for Window Assemblies: Products identical to those tested per ASTM E 163, labeled and listed by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

E. Insulating Glass Certification Program: Provide insulating glass units permanently marked either on spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency indicated below:

   1. Insulating Glass Certification Council (IGCC).

   2. Associated Laboratories, Inc. (ALI).

   3. National Certified Testing Laboratories (NCTL).

F. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in service performance.

G. Single Source Responsibility for Glass: Obtain glass from one source for each product indicated below:

   1. Primary glass of each (ASTM C 1036) type and class indicated.

   2. Heat treated glass of each (ASTM C 1048) condition indicated.

   3. Laminated glass of each (ASTM C 1172) kind indicated.

   4. Insulating glass of each construction indicated.

H. Single Source Responsibility for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

   1. Glass Products: Erect mockups with the following kinds of glass to match glazing systems required for Project, including typical lite size, framing systems, and glazing methods:

      a. Heat strengthened coated glass.

      b. Fully tempered glass.

      c. Spandrel glass.

      d. Laminated glass.

      e. Coated insulating glass.

      f. Place mockups at the Project Site in location and of size indicated or, if not indicated, as approved by Architect.

2. Notify Architect one week in advance of the dates and times when mockups will be erected.
3. Obtain Architect's acceptance of mockups before start of final unit of Work.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Retain and maintain mockups during construction in undisturbed condition as a standard for judging completed unit of Work.
   a. When directed, demolish and remove mockups from Project Site.
   b. Accepted mockups in undisturbed condition at time of Substantial Completion may become part of completed unit of Work.

I. Preconstruction Compatibility and Adhesion Testing: Submit to sealant manufacturers, samples of each glass, gasket, glazing accessory, and glass framing member that will contact or affect glazing sealants for compatibility and adhesion testing as indicated below:

1. Use test methods standard with sealant manufacturer to determine if priming and other specific preparation techniques are required for rapid, optimum glazing sealants adhesion to glass and glazing channel substrates.
   a. Perform tests under normal environmental conditions during installation.
   b. Submit not less than nine pieces of each type and finish of glass framing members and each type, class, kind, condition, and form of glass (monolithic, laminated, insulating units) for adhesion testing, as well as one sample of each glazing accessory (gaskets, setting blocks and spacers) for compatibility testing.
2. Schedule sufficient time to test and analyze results to prevent delay in the Work.
3. Investigate materials failing compatibility or adhesion tests and get sealant manufacturer's written recommendations for corrective measures, including using special primers.
4. Testing is not required when glazing sealant manufacturer can submit required preparation data that is acceptable to Architect and is based on previous testing of current sealant products for adhesion to and compatibility with submitted glazing materials.

J. Pre-Installation Conference: Conduct conference at the Project Site to comply with requirements of Division 01.

1.5 SUBMITTALS

A. Product Data:

1. Submit manufacturer's technical data for each glazing material and fabricated glass product required, including installation and maintenance instructions.

B. Samples:

1. Submit, for verification purposes, 12 inch square samples of each type of glass indicated and 12 inch long samples of each color required (except black) for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative of adjoining framing system in color.

C. Record Documents:

1. Certificate: Submit certificates from respective manufacturers attesting that glass and glazing materials furnished for Project comply with requirements.

a. Separate certification will not be required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to authorities having jurisdiction.

b. Compatibility and Adhesion Test Report: Submit statement from sealant manufacturer indicating that glass and glazing materials have been tested for compatibility and adhesion with glazing sealants and interpreting test results relative to material performance, including recommendations for primers and substrate preparation needed to obtain adhesion.

2. DELIVERY, STORAGE and HANDLING

D. Protect glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1. Where insulating glass units will be exposed to substantial altitude changes, comply with insulating glass fabricator's recommendations for venting and sealing to avoid hermetic seal ruptures.

2. system performance requirements

E. Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; and other defects in construction.

F. Glass Design: Glass thicknesses indicated on Drawings are for detailing only. Confirm glass thicknesses by analyzing Project loads and in service conditions. Provide glass lites for the various size openings in the thicknesses and strengths (annealed or heat treated) to meet or exceed the following criteria:

1. Select minimum glass thickness to comply with ASTM E 1300 according to following requirements:

a. Design wind loads- Determine design wind loads applicable to project according to ASCE 7: Section 6.5 based on mean roof heights above grade as indicated on drawings.

b. Tinted and heat absorbing glass thicknesses for each tint indicated are the same throughout Project.

2. Minimum glass thicknesses of lites, whether composed of annealed or heat treated glass, are selected so the worst case probability of failure does not exceed the following:

a. 8 lites per 1000 for lites set vertically or not over 15 degrees off vertical and under wind action. Determine minimum thickness of monolithic annealed glass according to ASTM E 1300. For other than monolithic annealed glass, determine thickness per glass manufacturer's standard method of analysis including applying adjustment factors to ASTM E 1300 based on type of glass.

b. 1 lite per 1000 for lites set over 15 degrees off vertical and under action of wind or snow.

G. Normal thermal movement results from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on materials' actual surface temperatures due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

2. Project conditions

H. Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing materials manufacturer or when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Install liquid sealants at ambient and substrate temperatures above 40 degrees F (4.4 degrees C).

2. warranty

I. Warranties specified in this Section shall not deprive The University of other rights The University may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

J. Manufacturer's Warranty on Coated Glass Products: Submit written warranty signed by coated glass manufacturer agreeing to furnish replacements for those coated glass units that deteriorate as defined in "Definitions" article, f.o.b. point of manufacture, freight allowed Project Site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to glass manufacturer's published instructions.
   1. Warranty Period: Manufacturer's standard but not less than five (5) years after date of Substantial Completion.

K. Manufacturer's Warranty on Laminated Glass: Submit written warranty signed by insulating glass manufacturer agreeing to furnish replacements for those laminated glass units that deteriorate as defined in the "Definitions" article, f.o.b. point of manufacture, freight allowed Project Site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to glass manufacturer's published instructions.

   1. Warranty Period: Manufacturer's standard but not less than five (5) years after date of Substantial Completion.

L. Manufacturer's Warranty on Insulating Glass: Submit written warranty signed by manufacturer of insulating glass agreeing to furnish replacements for insulating glass units that deteriorate as defined in "Definitions" article, f.o.b. point of manufacture, freight allowed Project Site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, protecting, and maintaining practices contrary to glass manufacturer's published instructions.

   1. Warranty Period: Manufacturer's standard but not less than ten (10) years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 primary glass products

A. Glass Type "1": Clear float glass conforming to ASTM C 1036, Type I, Class 1, Quality q3; ¼ inch thick.

B. Glass Type "2": Clear float glass conforming to ASTM C 1036, Type I, Class 1, Quality q3, which has been fully tempered by manufacturer's standard process (after cutting to final size), to achieve a flexural strength of 4 times normal glass strength, in accordance with ASTM C 1048, Condition A; ¼ inch thick.

C. Glass Type "5": Bronze tinted float glass conforming to ASTM C 1036, Type I, Class 2, Quality q3, which has been fully tempered by manufacturer's standard process (after cutting to final size), to achieve a flexural strength of 4 times normal glass strength, in accordance with ASTM C 1048, Condition A; 1/4 inch thick with a visible light transmittance of 55 percent, Reflectance of 6 percent, and a shading coefficient of 0.73.

D. Glass Type "6": Laminated glass conforming to ASTM C1172, 9/16 inch nominal overall thickness, consisting of an outboard light of 1/4 inch thick clear float glass laminated with a 0.060 inch thick polyvinyl butyral interlayer to an inboard light of 1/4 inch thick clear float glass.

E. Glass Type "7": Laminated glass conforming to ASTM C1172, consisting of 2 sheets of clear float glass, 1/8 inch thick, complying with ASTM C 1036, Type I, Class 2, laminated with a 0.030 inch thick polyvinyl butyral interlayer by manufacturer's standard heat-plus-pressure process with dirt, air pockets, and foreign substances excluded.

F. Bullet Resistant Glass: Laminated, clear float glass, Type I, Class 1, Quality q3, minimum of 1 3/16 inch (30 mm) thickness, conforming to UL Test No. 752, Fifth Edition, "Standard for Bullet Resisting Equipment" for resistance to medium power small arms. Appearance and performance data equivalent to Globe Amerada Glass Company "BR 136" bullet resisting glass.

2.3 PATTERNED GLASS PRODUCTS

A. Patterned Glass: ASTM C 1036, Type II, Class 1 (clear), Form 3 (patterned), Quality q8 (glazing), Finish f1 (patterned one side), of pattern indicated.

B. Tempered Patterned Glass: ASTM C 1048, Kind FT (fully tempered), Type II (patterned glass, flat), Class 1 (clear), Form 3 (patterned), Quality q8 (glazing), Finish f1 (patterned one side), of pattern indicated.

2.4 FIRE RESISTIVE GLAZING PRODUCTS

A. Fire Resistive, Ceramic Glazing Material: Proprietary product in the form of clear flat sheets of 5.0 mm (3/16 inch) nominal thickness, weighing 2.5 psf, permanently labeled with appropriate marks of testing and inspecting agency, acceptable to authorities having jurisdiction, showing product complies with fire resistive installation indicated, and as follows:

1. Polished on both surfaces, transparent with visible light transmission of 76.9 percent.
2. Unpolished on both surfaces, transparent.
3. Product: Subject to compliance with requirements, provide the following product manufactured by Nippon Electric Glass Co., Ltd. and distributed by Technical Glass Products:
   a. Premium FireLite.
   b. Standard FireLite.
   c. Fire Resistance: 45 minutes as determined by testing identical products in door and window assemblies per ASTM E 152 and ASTM E 163 by a testing and inspecting agency acceptable to authorities having jurisdiction.
4. Product: Subject to compliance with requirements, provide Pyrovue Commercial by Advanced Glass Systems Corp.

5. mirror glass

B. Primary Glass: Float glass complying with ASTM C 1036 requirements for Type I (transparent, flat) and for class and quality indicated below:

1. Clear Float Glass: Quality q2 (mirror), Class 1 (clear).

C. Tempered Glass: Tempered float glass manufactured by horizontal (roller hearth) process with roll wave distortion parallel with bottom edge of glass as installed, unless otherwise indicated, complying with ASTM C 1048 for Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent, flat), Quality q3 (glazing select), and for class indicated below:

1. Clear Tempered Float Glass: Class 1 (clear).

D. Transparent (One Way) Mirror Glass: Clear float glass, ASTM C 1036, Type I, Class 1, Quality q3; 1/4 inch thick, with chrome alloy or similar reflective metallic coating permanently deposited on one face of glass, with sufficient abrasion resistance to permit repeated cleaning with non abrasive compound and soft cotton cloth without significant removal of coating.

2.5 MIRRORED GLASS PRODUCTION AND FABRICATION

A. Glass Coating: Coat second surface of glass with successive layers of chemically deposited silver, electrically or chemically deposited copper, and manufacturer's standard protective organic coating to produce coating system that complies with FS DD M 0041, except with salt spray test period extended to 300 hours and undercutting, discolorations, blackening, and silver impairment at mirror edges not greater than 1/8 inch.

B. Mirror Edge Treatment: Provide forms of edge treatment indicated below, with edges sealed after treatment to prevent chemical or atmospheric penetration of glass coating:

1. Flat polished edge.
2. Rounded polished edge.
3. Beveled polished edge of width shown.
4. Perform edge treatment and sealing in factory immediately after cutting to final sizes.

5. ELASTOMERIC GLAZING SEALANTS

C. Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants and tapes of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.
2. Suitability: Comply with sealant and glass manufacturer's recommendations for selecting glazing sealants and tapes that are suitable for applications indicated and conditions existing at time of installation.
3. Colors: Provide color of exposed joint sealants to comply with the following:
    a. Match colors indicated by reference to manufacturer's standard designations.
    b. Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.

D. Elastomeric Glazing Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that comply with ASTM C 920 requirements for Type, Grade, Class and Uses.

E. Glazing Sealant for Fire Resistant Glazing Products: Identical to product used in test assembly to obtain fire resistive rating.

2.6 GLAZING TAPES

A. Back Bedding Mastic Glazing Tape: Preformed, butyl based elastomeric tape with a solids content of 100 percent, nonstaining and nonmigrating in contact with nonporous surfaces, with or without spacer rod as recommended by tape and glass manufacturers for application indicated, packaged on rolls with a release paper backing, and complying with AAMA 800.

B. Expanded Cellular Glazing Tape: Closed cell, polyvinyl chloride foam tape, factory coated with adhesive on both surfaces, packaged on rolls with release liner protecting adhesive, and complying with AAMA 800 for product 810.5.

C. Products: Subject to compliance with requirements, provide one of the following:

1. Back Bedding Mastic Glazing Tape Without Spacer Rod:

    a. PTI 303 Glazing Tape (shimless), Protective Treatments, Inc.

    b. S M 5700 Poly Glaze Tape Sealant, Schnee Morehead, Inc.

    c. Tremco 440 Tape, Tremco Inc.

    d. Extru Seal, Pecora Corp.

    e. PTI 606 Architectural Sealant Tape, Protective Treatments, Inc.

    f. Dyna Seal, Pecora Corp.

    g. PTI 626 Architectural Sealant Tape, Protective Treatments, Inc.

    h. S M 5710 H.P Poly Glaze Tape Sealant, Schnee Morehead, Inc.

    i. SST 800 Tape, Tremco, Inc.

    j. Back Bedding Mastic Glazing Tape With Spacer Rod:
    k. PTI 303 Glazing Tape (with shim), Protective Treatments, Inc.

    l. Pre shimmed Tremco 440 Tape, Tremco, Inc.

    m. PTI 606 Architectural Sealant Tape, Protective Treatments, Inc.

    n. Expanded Cellular Glazing Tape:
    o. Norseal V 980 Closed Cell Glazing Tape, Norton Company.

2.7 GLAZING GASKETS

A. Lock Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock strips, complying with ASTM C 542, black.

B. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:

1. Neoprene, ASTM C 864.

2. EPDM, ASTM C 864.

3. Silicone, ASTM C 1115.

4. Thermoplastic polyolefin rubber, ASTM C 1115.

5. Any material indicated above.

C. Soft Compression Gaskets: Extruded or molded closed cell, integral skinned gaskets of material indicated below, complying with ASTM C 509, Type II, black, and of profile and hardness required to maintain watertight seal:

1. Neoprene.

2. EPDM.

3. Silicone.

4. Thermoplastic polyolefin rubber.
5. Any material indicated above.

D. Manufacturers: Subject to compliance with requirements, provide products by one of the following companies.

1. Lock Strip Gaskets: Stanlock Div., Griffith Rubber Mills.
2. Preformed Gaskets:
    a. Advanced Elastomer Systems, L.P.
    b. Schnee Morehead, Inc.
    c. Tremco, Inc.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials involved for glazing application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85 plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Plastic Foam Joint Fillers: Preformed, compressible, resilient, nonstaining, nonextruding, nonoutgassing, strips of closed cell plastic foam of density, size, and shape to control sealant depth and otherwise contribute to produce optimum sealant performance.

G. Perimeter Insulation for Fire Resistive Glazing: Identical to product used in test assembly to obtain fire resistive rating.

2.9 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard as required to comply with system performance requirements.

B. Clean cut or flat grind vertical edges of butt glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine glass framing, with glazier present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.
2. Presence and functioning of weep system.

3. Minimum required face or edge clearances.

4. Effective sealing between joints of glass framing members.

B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

C. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Glazing – General:

1. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.

2. Glazing channel dimensions as indicated on Drawings provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

3. Protect glass from edge damage during handling and installation as follows:

    a. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.

    b. Remove damaged glass from Project Site and legally dispose of off Site. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.

    c. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant substrate testing.

4. Install elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

5. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

6. Provide spacers for glass sizes larger than 50 united inches (length plus height) as follows:

    a. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.

    b. Provide 1/8 inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

    c. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.

7. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

8. Where wedge shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

9. Square cut wedge shaped gaskets at corners and install gaskets in manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

D. Tape Glazing:

1. Position tapes on fixed stops so that when compressed by glass their exposed edges are flush with or protrude slightly above sightline of stops.

2. Install tapes continuously but not in one continuous length. Do not stretch tapes to make them fit opening.

3. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.

4. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

5. Do not remove release paper from tape until just before each lite is installed.

6. Apply heel bead of elastomeric sealant.

7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

8. Apply cap bead of elastomeric sealant over exposed edge of tape.

E. Gasket Glazing (Dry):

1. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.

2. Secure compression gaskets in place with joints located at corners to compress gaskets producing a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

3. Install gaskets so they protrude past face of glazing stops.

F. Sealant Glazing (Wet):

1. Install continuous spacers between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

3. Tool exposed surfaces of sealants to provide a substantial wash away from glass. Install pressurized gaskets to protrude slightly out of channel to eliminate dirt and moisture pockets.

G. Lock Strip Gasket Glazing:

1. Comply with ASTM C 716 and gasket manufacturer's printed recommendations. Provide supplementary wet seal and weep system unless otherwise indicated.

2. PROTECTION AND CLEANING

H. Protect exterior glass from breakage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

I. Protect glass from contact with contaminating substances resulting from construction operations including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

J. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build up of dirt, scum, alkali deposits, or stains, and remove as recommended by glass manufacturer.

K. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents and vandalism, during construction period.

L. Wash glass on both faces in each area of Project not more than four (4) days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

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SECTION 08 83 00 00 – MIRRORS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of material for mirrors. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the products manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. Section includes the following types of silvered flat glass mirrors:
    a. Annealed monolithic glass mirrors.
    b. Film-backed, Laminated and Tempered glass mirrors qualifying as safety glazing.

C. Submittals
  1. Product Data: For each type of product indicated.
    a. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
  2. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work, thickness and coatings.
  3. Samples: For each type of the following products:
    a. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.
    b. Mirror Clips: Full size.
    c. Mirror Trim: 12 inches (300 mm) long.
  4. Qualification Data: For qualified Installer.
  5. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.
  6. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing paint **OR** film and substrates on which mirrors are installed.
  7. Maintenance Data: For mirrors to include in maintenance manuals.

D. Quality Assurance

1. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
2. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
3. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.
4. Glazing Publications: Comply with the following published recommendations:
    a. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
    b. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
5. Safety Glazing Products: For film-backed, laminated and tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

E. Delivery, Storage, And Handling
1. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
2. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

F. Project Conditions
1. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
    a. Warranty Period: Five years from date of Substantial Completion.

1.4 PRODUCTS

A. Silvered Flat Glass Mirrors
1. Glass Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.
2. Clear Glass: Mirror Select **OR** Glazing, **as directed**, Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission, **as directed**.
    a. Nominal Thickness: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
3. Tempered Clear **OR** Tinted, **as directed**, Glass: Mirror Glazing Quality, for blemish requirements; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
    a. Nominal Thickness: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
4. Laminated Mirrors: ASTM C 1172, Kind LM.
    a. Clear Glass for Outer Lite: Mirror Select **OR** Glazing, **as directed**, Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission, **as directed**.
    b. Tinted Glass for Outer Lite: Mirror Glazing Quality.
        1) Tint Color: Blue **OR** Black **OR** Bronze **OR** Gold **OR** Gray **OR** Green **OR** Peach **OR** Pink, **as directed**.

- c. Nominal Thickness for Outer Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
- d. Glass for Inner Lite: Annealed float glass; ASTM C 1036, Type I (transparent flat glass), Quality-Q3; Class 1 (clear).

  OR

  Glass for Inner Lite: Heat-treated float glass; ASTM C 1048 Type I; Quality-Q3; Class I (clear) Kind HS, Condition A.

  OR

  Glass for Inner Lite: Tempered float glass; ASTM C 1048 Type I; Quality-Q3; Class I (clear), Kind FT, Condition A.
- e. Nominal Thickness for Inner Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
- f. Interlayer: Mirror manufacturer's standard 0.030-inch- (0.76-mm-) thick, clear polyvinyl-butyral interlayer with a proven record of showing no tendency to delaminate from, or cause damage to, silver coating.

B. Miscellaneous Materials

- 1. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- 2. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- 3. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
- 4. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

C. Mirror Hardware

- 1. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
  - a. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch (9.5 and 22 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm) **OR** 0.05 inch (1.3 mm), **as directed**.
  - b. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch (16 and 25 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm) **OR** 0.062 inch (1.57 mm), **as directed**.
  - c. Finish: Clear **OR** Gold, **as directed**, bright anodized.
- 2. Top Channel/Cleat and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
  - a. Bottom Trim: J-channels formed with front leg and back leg not less than 5/16 and 3/4 inch (7.9 and 19 mm) in height, respectively.
  - b. Top Trim: Formed with front leg with a height of 5/16 inch (7.9 mm) and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.
  - c. Finish: Clear **OR** Gold, **as directed**, bright anodized.
- 3. Mirror Bottom Clips: As indicated.
- 4. Mirror Top Clips: As indicated.
- 5. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.
  - a. Profile: As indicated.
  - b. Finish: Selected from manufacturer’s standards.
- 6. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- 7. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

D. Fabrication
1. Mirror Sizes: To suit Project conditions, and before tempering, **as directed**, cut mirrors to final sizes and shapes.
2. Cutouts: Fabricate cutouts before tempering, **as directed**, for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.
3. Mirror Edge Treatment: Flat polished **OR** Rounded polished **OR** Flat high-polished **OR** Rounded high-polished **OR** Beveled polished edge of width shown, **as directed**.
    a. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
    b. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.
4. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

1.5 EXECUTION

A. Examination
1. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
2. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
3. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

B. Preparation
1. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

C. Installation
1. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
2. Provide a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
3. Wall-Mounted Mirrors: Install mirrors with mirror hardware **OR** mastic and mirror hardware, **as directed**. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
    a. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
    b. Top Channel/Cleat and Bottom Aluminum J-Channels: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
    c. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips where indicated **OR** so they are symmetrically placed and evenly spaced, **as directed**.
    d. Install mastic as follows:
        1) Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
        2) Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.

        3) After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.

D. Cleaning And Protection
    1. Protect mirrors from breakage and contaminating substances resulting from construction operations.
    2. Do not permit edges of mirrors to be exposed to standing water.
    3. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
    4. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.
    5. Remove labels from mirror surface

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SECTION 08 90 00 00 – LOUVERS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 definitions

A. Louver Terminology: Refer to AMCA Publication 501 85 for definitions of terms for metal louvers not otherwise defined in this section or referenced standards.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain louvers and vents from a single source where alike in one or more respects with regard to type, design, and factory applied color finish.

B. Qualify welding processes and welding operators in accordance with D1.2 "Structural Welding Code Aluminum" and D1.3 "Structural Welding Code Sheet Steel."

1. Certify that each welder employed in unit of Work of this section has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

2. Testing for recertification is Contractor's responsibility.

3. Engineer Qualifications: Professional engineer licensed to practice in jurisdiction where Project is located and experienced in providing engineering services of the kind indicated which has resulted in the successful installation of louvers similar in material, design, and extent to that indicated for this Project.

C. SMACNA Standard: Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures.

D. UL and NEMA Compliance: Provide motors and related components for motor operated adjustable louvers which are listed and labeled by UL and comply with applicable NEMA standards.

1.5 SUBMITTALS

A. General:

1. Where installed products are indicated to comply with certain structural design loadings, include structural computations, material properties, and other information needed for structural analysis which has been prepared by, or under the supervision of, a qualified professional engineer

2. Product Data:
   3. Manufacturer's product data for each product.

4. Samples:
   5. Samples for initial selection purposes in form of manufacturer's color charts showing full range of colors available for those units with factory applied color finishes.

   6. Samples for verification purposes of each type of metal finish required, prepared on six inch square metal samples of same thickness and alloy indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

7. Shop Drawings:
   8. Shop drawings of louver units and accessories. Include plans, elevations, sections, and details showing profiles, angles, spacing of louver blades; unit dimensions related to wall openings and construction; free areas for each size indicated; and profiles of frames at jambs, heads and sills.

9. Record Documents:
   10. Product test reports evidencing compliance of units with performance requirements indicated.

   11. Product certificates signed by louver manufacturers certifying that their products which comply with Project requirements are licensed to bear AMCA Seal based on tests made in accordance with AMCA Standard 500 and complying with AMCA Certified Ratings Program.

   12. Qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience.

1.6 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design, engineer, fabricate, and install exterior metal wall louvers to withstand the effects of loads and stresses from wind and normal thermal movement, without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter; and permanent damage to fasteners and anchors:

   1. Wind Load: Uniform pressure (velocity pressure) required by Code acting inwards or outwards.

   2. Normal thermal movement is defined as that resulting from the following maximum change (range) in ambient temperature. Base design calculations on actual surface temperatures of metals due to both solar heat gain and night time sky heat loss.

      a. Temperature Change (Range): 100 degrees F (55.5 degrees C).

B. Air Performance, Water Penetration, and Air Leakage Ratings: Provide louvers complying with performance requirements indicated as demonstrated by testing manufacturers stock units, of height and width indicated, according to Air Movement and Control Association (AMCA) Standard 500.

1.7 PROJECT CONDITIONS

A. Field Measurements: Check actual louver openings by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of the Work.

   1. Where field measurements cannot be made without delaying the Work, guarantee opening dimensions and proceed with fabrication of louvers and vents without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to guaranteed dimensions.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. To establish standards of manufacture, operation, performance, and appearance, drawings and specifications are based on products of Construction Specialties, Inc. Provided compliance with requirements, products of the following manufacturers will also be acceptable:

1. Ruskin Mfg. Div., Phillips Industries, Inc.
2. Or Approved Equal

2.3 materials

A. Galvanized Steel Sheet: ASTM A 526 or A 527, G90 zinc coating, mill phosphatized.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer to produce required finish.

C. Aluminum Extrusions: ASTM B 221, Alloy 6063 T5 or T 52.

D. Fasteners: Of same basic metal and alloy as fastened metal, unless otherwise indicated. Do not use metals which are corrosive or incompatible with materials joined.

1. Use types, gages, and lengths to suit unit installation conditions.
2. Use Phillips flat head machine screws for exposed fasteners, unless otherwise indicated.
3. Anchors and Inserts: Of type, size, and material required for type of loading and installation indicated. Use nonferrous metal or hot dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled in place anchors.

E. Bituminous Paint: SSPC Paint 12 (cold applied asphalt mastic).

F. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel, complying with SSPC Paint 20.

2.4 FABRICATION, GENERAL

A. Fabricate louvers and vents to comply with requirements indicated for design, dimensions, materials, joinery, and performance.

B. Preassemble louvers in shop to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of size indicated with allowances made for fabrication and installation tolerances of louvers, adjoining construction, and perimeter sealant joints.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated but not further apart than recommended by manufacturer, or 72 inches on center, whichever is less. At horizontal joints between louver units provide horizontal mullions except where continuous vertical assemblies are indicated.

G. Provide sill extensions and loose sills made of same material as louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.

H. Join frame members to one another and to fixed louver blades as follows, unless otherwise indicated, or size of louver assembly makes bolted connections between frame members necessary:

   1. With fillet welds, concealed from view.

2.5 STORM RESISTANT LOUVERS

A. Provide extruded aluminum louvers, stationary, storm proof type, with extrusions not less than 0.081 inches thick. Provide 5 inches deep units; Construction Specialties, Architectural Louvers, "Model RS 5300" or accepted equivalent.

2.6 LOUVER SCREENS

A. Provide each exterior louver with louver screens complying with the following requirements:

   1. Screen Location for Fixed Louvers: Interior face, unless otherwise indicated.

   2. Screening Type: Bird screening, unless otherwise indicated.

   3. Secure screens to louver frames with stainless steel machine screws, spaced at each corner and at 12 inch on center between.

B. Louver Screen Frames: Fabricate screen frames with mitered corners to louver sizes indicated and to comply with the following requirements:

   1. Metal: Same kind and form of metal as indicated for louver frames to which screens are attached.

      a. Reinforce extruded aluminum screen frames at corners with clips.

   2. Finish: Same finish as louver frames to which louver screens are attached.

   3. Type: Non-rewireable U shaped frames for permanently securing screen mesh.

   4. Louver Screening for Aluminum Louvers: Fit aluminum louver screen frames with screening covering louver openings and complying with the following requirements:
   5. Bird Screening: 1/2 inch square mesh formed with 0.063 inch diameter aluminum wire.

2.7 BLANK OFF PANELS

A. Fabricate blank off panels from materials and to sizes indicated and to comply with the following requirements:

   1. Finish: Match finish applied to louvers with respect to coating type, color and gloss.

   2. Attach blank off panels to back of louver frames with clips.

   3. Non-insulated Blank Off Panels: Metal sheet complying with the following requirements:
   4. Aluminum sheet for aluminum louvers, thickness as follows:

      a. 0.051 inch, unless otherwise indicated.

      b. ALUMINUM FINISHES

B. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

C. Finish louvers after assembly.

D. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.

E. Class I Clear Anodized Finish: AA M12C22A41 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural: clear film thicker than 0.7 mil) complying with AAMA 607.1.

F. Conversion Coated Finish: AA C12C42 (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate fluoride phosphate pretreatment).

G. Conversion Coated and Factory Primed Finish: AA C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate fluoride phosphate pretreatment; Organic Coating: as specified below).

1. Organic Coating: Air dried zinc chromate primer with not less than 2.0 mils dry film thickness.

2. Class I Color Anodized Finish: AA M12C22A42/A44 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, Medium Matte; Anodic Coating: Class II Architectural, film thicker than 0.7 mil with integral color or electrolytically deposited color) complying with AAMA 606.1 or AAMA 608.1.
3. Color: Light bronze.

4. Color: Medium bronze.

5. Color: Dark bronze.

6. Color: Black.

7. Color: Match Architect's sample.

8. Color: As selected by Architect from within standard industry colors and color density range.

9. Baked Enamel Finish: AA C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate fluoride phosphate pretreatment; Organic Coating: as specified below). Apply baked enamel in compliance with paint manufacturer's specifications for cleaning, conversion coating, and painting.
10. Organic Coating: Thermosetting modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with minimum dry film thickness of 1.5 mils, medium gloss.

11. Color: As indicated by reference to manufacturer's standard color designations.

12. Color: Match Architect's samples.

13. Color: As selected by Architect from manufacturer's standard colors.

14. High Performance Organic Coating: AA C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate fluoride phosphate pretreatment; Organic Coating: as specified below) Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.
15. Fluorocarbon 2 Coat Coating System: Manufacturer's standard 2 coat thermo cured system, composed of specially formulated inhibitive primer and fluorocarbon color topcoat containing not less than 70 percent polyvinylidene resin by weight; complying with AAMA 605.2.

16. Fluorocarbon 3 Coat Coating System: Manufacturer's standard 3 coat thermo cured system composed of specially formulated inhibitive primer, fluorocarbon color coat, and clear fluorocarbon topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene resin by weight; complying with AAMA 605.2.
    a. Color and Gloss: As indicated by reference to manufacturer's standard color and sheen designations.
    b. Color and Gloss: Match Architect's sample.
    c. Color and Gloss: As selected by Architect from manufacturer's standard choices for color and gloss.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to the Project Site.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Locate and place louver units plumb, level, and in proper alignment with adjacent Work.

D. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

E. Form closely fitted joints with exposed connections accurately located and secured.

F. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

G. Repair finishes damaged by cutting, welding, soldering, and grinding operations require for fitting and jointing. Restore finishes so there is no evidence of corrective Work. Return items which cannot be refinished in field to shop, make required alterations and refinish entire unit, or provide new units.

H. Protect galvanized and nonferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry, or dissimilar metals.

I. Install concealed gaskets, flashings, joint fillers, and insulation, as louver installation progresses where required to make louver joints weathertight. Comply with Division 07 Section "Joint Sealers" for sealants applied during installation of louver.

3.3 ADJUSTING AND PROTECTION

A. Protect louvers and vents from damage of any kind during construction period including use of temporary protective coverings where needed and approved by louver manufacturer. Remove protective covering at time of Substantial Completion.

B. Restore louvers and vents damaged during installation and construction period, so that no evidence remains of correction Work. If results of restoration are unsuccessful, as judged by Architect, remove damaged units and replace with new units.

1. Clean and touch up minor abrasions in finishes with air dried coating that matches color and gloss of, and is compatible with, factory applied finish coating.

2. Test operation of adjustable wall louvers and adjust as needed to produce fully functioning units which comply with requirements.

3.4 CLEANING

A. Periodically clean exposed surfaces of louvers and vents, which are not protected by temporary covering, to remove fingerprints and soil during construction period; do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and with a mild soap or detergent not harmful to finishes. Rinse thoroughly and dry surface.

END OF SECTION 08 90 00 00

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SECTION 09 00 00 00 – FINISHES DESIGN CRITERIA

1.1 GENERAL

A. For renovation projects, the building's character and existing finishes must be considered. All material patches must blend as closely as possible. Some buildings on campus have an existing palette that must be matched. Coordinate any consideration for variances with the UT Health Project Manager.

B. All finish selections require design review by UT Health Facilities Management Design Team.

C. All specified materials must have a demonstrated history of at least five years in a similar institutional setting, with similar regularity of cleaning and maintenance.

D. UT Health Facilities Management Design Team shall approve any custom-designed colors and finish materials.

E. Construction documents must clearly identify and note all finishes, including their extent of coverage.

F. Coordinate requirements for attic stock with the UT Health Project Manager.

G. All finishes must complete off-gassing prior to Substantial Completion. Refer to EHS Odorous Chemicals Guidance Document for Odor Threshold Values.

H. Specify and install materials that do not contain asbestos or lead. Lead amounts are defined by current federal law for floors and walls. Contact UT Health Project Management, specification Section 02, and the UT Health EHS Department for any abatement involved in a project.

1.2 SUSTAINABLE DESIGN:

A. The UT Health promotes energy-efficient green design, construction, and building operations.

B. Materials are (recommended where applicable) to be specified following the United States Green Building Council's LEED (Leadership in Energy and Environmental Design) Green Building Rating System®.

1. Finishes should meet the most current version of LEED for Low Emitting Materials.

2. Finishes should not exceed VOC limits established by the South Coast Air Quality Management (SCAQMD) Rule 1113.

09 20 00 PLASTER AND GYPSUM BOARD

1.1 GENERAL PROVISIONS:

A. Wall boards less than 5/8" thick are prohibited, unless with special written permission for UT Health Project Manager.

1.2 PLASTER AND GYPSUM BOARD MATERIALS:

A. 09 21 13 Plaster Assemblies:

1. When used at ceilings or soffits, provide access panels where required.

B. 09 21 16 Gypsum Board Assemblies:

1. Follow industry standard STC levels for different occupancy types unless specifically directed otherwise by the UT Project Manager.

2. Gypsum board should meet the most current LEED Standard for building product disclosure and optimization (i.e.: Recycled Content, Regional Materials, Rapidly Renewable Materials, Low-Emitting Materials – environmental product declarations).

C. 09 28 00 Backing Boards and Underlayments:

WET AREAS REQUIRING ADDITIONAL PROTECTION

Usage Areas	**Cement Board**	**Fiber-Cement Board**	**Coated Glass- Mat**	**Fiber-Reinforced Gypsum Board**	**NOTES**
Autoclave Room	●	●	●	●	All walls
Bathroom	●	●	●	●	Behind commodes, urinals sink.
Breakroom	●	●	●	●	Behind cabinetry and fridge
Cold Room	●	●			Insulation between walls and backerboard on all abutting walls of the cold room.
Janitorial Closet	●	●	●	●	All walls
Kitchen	●	●	●	●	Backerboard is required because seams are not impervious.
Laundry Room	●	●	●	●	Walls and ceiling required.
Mop Sink	●	●	●	●	Behind sink and 2’-4’ on each side
Plumbing Chase	●	●			All walls
Shower	●	●			Walls and ceiling required.
Sub-Grade Wall	●	●			
Vivarium	●	●	●	●	
Water Fountain Back-splash	●	●	●	●	Behind the fountain and 2’-4’ on each side.
Wet Lab	●	●			

This table is to be used for new construction and renovations. Gypsum wallboard and ‘green board’ are not to be used in the areas listed in this table. The dot indicates the building material is acceptable for that location.

Computer server rooms that share common walls with a temperature differential in the rooms greater than 5ºF will require insulation between walls and Cement Board or Fiber-Cement Board on all abutting walls of the server room.

D. 09 29 00 Gypsum Board:

1. Use fire-resistant gypsum board wherever gypsum board is used.
2. High-traffic areas: use impact-resistant, fiberglass-mat faced gypsum board.
3. Paper-faced, moisture resistant, or ‘green’ wallboard is prohibited in wet areas.

09 30 00 TILE

1.1 TILE AT WALLS:

A. Restrooms: Provide ceramic tile finish at all walls, not only wet walls, to at least ±6’-0” above finish floor level, in whole tile increments. Where existing ceilings are in place, leave approximately 12” (minimum) of painted wallboard from the ceiling.

B. Glazed tile containing any amount of lead is prohibited.

1.2 GROUT:

A. Use epoxy-type grout meeting ANSI 118.3.

B. Dark colors are required for the floor and base.

1.3 ADHESIVE:

A. Tile adhesive should meet the most current LEED Standards for Indoor Air Quality, Recycled Materials, and Regional Materials.

09 50 00 CEILINGS

1.1 GENERAL PROVISIONS:

A. Review proposed ceiling types with the UT Health Project Manager. UT Health is open to a variety of ceiling solutions, with the following stipulations:

1. All ceilings should be designed to be easily accessible for maintenance and other access requirements, such as future technology installations.
2. Suspended acoustical ceiling systems are recommended for most areas. UT Health Project Manager shall approve variations from this.
    a. Suspended 2 x 4 ceiling system - Armstrong Prelude ML 15/16” tiles - Ultima lay-in 15/16" #1900 or approved equal in non-specialized areas.

B. Ceiling tile should meet the most current LEED Standards such as Energy Performance, Indoor Air Quality, Resource Reuse, and Regional Materials, as appropriate for the Work.

1.2 CEILING REQUIREMENTS IN SPECIFIC SPACES:

A. Toilet room ceilings shall be cementitious backer board or glass-mat gypsum board.

B. Ceilings in food preparation areas (i.e. kitchens, excluding department or staff break rooms) shall be designed, constructed, and installed so that they are continuous, smooth, and easily cleanable.

C. Concealed spline ceiling support systems are prohibited.

D. Follow industry standard STC levels for different occupancy types unless specifically directed otherwise by the UT Project Manager.

E. Locations subject to moisture penetration or condensation shall use stainless steel hanger wires for suspension systems.

09 60 00 FLOORING

1.1 GENERAL FLOORING PROVISIONS:

A. All flooring must be from a known, established manufacturer/dealer (with local representation) who has been producing or selling the product for a minimum of 5 years.

B. All flooring must have nationally recognized/industry-accepted sustainability certification relative to the material.

C. Slip resistance:

1. Install flooring with a higher COF in areas where people may be carrying objects, pushing or pulling objects, walking up or down ramps or in areas that are generally slippery because of wet or oily operations, operations that result in debris on floor surfaces, or where water may be tracked in from outside. Space function may determine a higher COF.

2. For additional information, flooring must have a static coefficient of friction (COF) that meets Texas Accessibility Standards Section 302.

D. For renovation projects, existing flooring should be removed prior to installation of any new flooring or flooring components. There is no exception for installing new finishes over hazardous material.

1. When 20% of the floor area in the project scope is being abated as part of the work, then the remaining floor area is required to be fully abated.

1.2 FLOORING REQUIREMENTS IN SPECIFIC SPACES:

A. Public area flooring:

1. Building entries: Provide walk-off areas:

   a. Recessed area with walk-off carpet tile.
   b. Walk-off carpet tile.
   c. Recessed open grill systems are prohibited.

B. Restrooms:

1. A floor drain shall be provided. Refer to Division 22 for floor drain requirements.

C. Biological laboratories:

1. Seamless chemical-resistant floor covering is required. Welded seams are recommended.

2. Vinyl composition tile (VCT) and other adhered tile products are prohibited.

D. Vivariums:

1. Floor and wall junctures must be coved. Review standard requirements with UT EHS and coordinate with the UT Project Manager prior to proceeding.

09 80 00 SOUND ISOLATION

1.1 GENERAL PROVISIONS:

A. Methods to use shall incorporate sound attenuation blankets, full height drywall assembly to the structural deck above ceilings, sound sealant, proper spacing of return air grills, sound transmission boots, etc.

END OF STANDARD

SECTION 09 21 00 00 – PLASTER & GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Special Requirements of Regulatory Agencies: Submit certification that system complies with VOC (Volatile Organic Compounds) requirements and regulations of the Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), State, County, City, and local Air Control District.

1.01.1.1.3 Fire Resistance Ratings: Where plaster systems with fire resistance ratings are indicated, provide materials and installations identical to those of applicable assemblies tested per ASTM E 119 by fire testing laboratories acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: As indicated by GA File Numbers in GA-600 "Fire Resistance Design Manual" or design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Provide plaster for fire resistance rated systems that has same aggregate as specified for similar nonrated Work, unless specified aggregate has not been tested by accepted fire testing laboratories.

B. Coordination of Work: Coordinate layout and installation of suspension system components for suspended ceilings with other work supported by or penetrating through ceiling.

1.01.1.1.4 Field Constructed Mock Up: Prior to installation of plaster work, fabricate panels for each type of finish and application required to verify selections made under sample submittals and to demonstrate aesthetic effects of application as well as qualities of materials and erection. Build mock ups to comply with the following requirements, using materials indicated for final unit of Work.

1. Locate mock ups on Site in location as approved by Architect.
2. Erect 10 foot by 10 foot by full thickness mock up using materials, including lath and support system, indicated for final work.
3. Demonstrate the proposed range of aesthetic effects including color, texture, and workmanship to be expected in completed work.
4. Obtain Architect's acceptance of mock ups before start of plaster work.

5. Retain and maintain mock ups during construction in undisturbed condition as a standard for judging completed plaster work.

1.01.1.1.4.1 SUBMITTALS

C. Record Documents:

1. Samples for verification purposes in units at least twelve inches square of each type of finish indicated, in sets for each color, texture, and pattern specified, showing full range of variations expected in these characteristics.

1.01.1.1.4.2 DELIVERY, STORAGE and HANDLING

D. Deliver materials in original packages, containers, or bundles bearing brand name and identification of the manufacturer.

1.01.1.1.5 Store materials inside, under cover, and in manner to keep them dry, protected from weather, direct sunlight, surface contamination, aging, corrosion, and damage from construction traffic and other causes.

1.4 PROJECT CONDITIONS

A. Comply with requirements of referenced plaster application standards and recommendations of plaster manufacturer for environmental conditions before, during, and after application of plaster.

1.01.1.1.6 When ambient outdoor temperatures are below 40 degrees F (4.4 degrees C), maintain continuous uniform temperature of not less than 40 degrees F (4.4 degrees C) nor more than 80 degrees F (26 degrees C) for not less than 1 week prior to beginning plaster application, during its application, and until plaster is dry but for not less than one week after application is complete. Distribute heat evenly; prevent concentrated or uneven heat from contacting plaster near heat source.

B. Ventilate building spaces as required to remove water in excess of that required for hydration of plaster. Begin ventilation immediately after plaster is applied and continue until it sets.

1.01.1.1.7 Protect contiguous Work from soiling, spattering, moisture deterioration and other harmful effects that might result from plastering.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 METAL SUPPORTS FOR SUSPENDED AND FURRED CEILINGS

A. Size metal ceiling supports to comply with the following, unless otherwise indicated.

1. Gypsum Plaster Installations: ASTM C 841.

2. Portland Cement Plaster Installation: ASTM C 1063.

B. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.

1.01.1.1.8 Rod Hangers: Mild steel, zinc or cadmium coated.

C. Flat Hangers: Mild steel, zinc or cadmium coated or protected with rust inhibitive paint.

1.01.1.1.9 Channels: Cold rolled steel, 0.05980 inch minimum thickness of base metal (uncoated), allowable bending stress of 18,000 psi, protected with rust inhibitive paint or galvanizing complying with ASTM A 525 for G60 coating designation, and as follows:

1. Carrying Channels: 1-1/2 inch deep by 7/16 inch wide flanges, 475 lbs. per 1000 feet painted, 508 lbs. per 1000 feet galvanized.

2. Furring Channels: 3/4 inch deep by 7/16 inch wide flanges, 300 lbs. per 1000 feet painted, 316 lbs. per 1000 feet galvanized.

3. Provide galvanized channels for exterior, and high-humidity interior, installations.

D. Hanger Anchorage Devices: Screws, cast in place concrete inserts, or other devices appropriate for anchorage to the form of structural framing indicated and whose suitability for use intended has been proven through standard construction practices or certified test data.

1. Size devices to develop full strength of hanger but not less than 3 times calculated hanger loading, except size direct pullout concrete inserts for 5 times calculated hanger loading.

1.01.1.1.9.1 LATH

E. Expanded Metal Lath: Fabricate expanded metal lath from uncoated or zinc coated (galvanized) steel sheet to produce lath complying with ASTM C 847 for type, configuration, and other characteristics indicated below, with uncoated steel sheet painted after fabrication into lath.

1. Diamond Mesh Lath: Comply with the following requirements:

a. Configuration: Flat, Weight: 3.4 lbs. per sq. yd.

b. Configuration: Self furring, Weight: 3.4 lbs. per sq. yd.

c. Paper Backing: Where paper backed diamond mesh lath is indicated, provide asphalt impregnated paper factory bonded to back and complying with FS UU B 790, for Type I, Grade D (vapor permeable), Style 2.

1.01.1.1.9.1.1 Rib Lath: Comply with the following requirements:
d. Configuration: Rib depth of 3/8 inch, Weight: 3.4 lbs. per sq. yd.

F. Lath Attachment Devices: Devices of material and type required by referenced standards and recommended by lath manufacturer for secure attachment of lath to framing members and of lath to lath.

2.3 PLASTER ACCESSORIES

A. Comply with material provisions of ASTM C 841 and ASTM C 1063; coordinate depth of accessories with thicknesses and number of coats required.

1.01.1.1.10 Metal Corner Reinforcement: Expanded large mesh diamond mesh lath fabricated from zinc alloy or welded wire mesh fabricated from 0.0475 inch diameter zinc coated (galvanized) wire and specially formed to reinforce external corners of portland cement plaster on exterior exposures while allowing full plaster encasement.
B. Fabricate metal beads and accessories from not less than 24 gage solid zinc alloy at exterior and "high humidity" interior areas and galvanized steel at other interior areas, except where extruded aluminum trim is shown. Coordinate depth of grounds with thickness and number of plaster coats required.

1. Square Edged Casing Beads: Manufacturer's standard with expanded or short flange to suit application.

2. Control Joints: Keene Corp. No. 15 roll formed control joints with expanded flanges at flat plaster areas and No. 30 roll formed control joints with expanded flanges at internal corners.

3. Two Piece Expansion Joints: Keene Corp. No. 40 roll-formed casing beads with modified back flanges providing positive slip joint action and dust barrier, adjustable for joint width variation of 1/8 inch to 5/8 inch.

4. Cornerite: Manufacturer's standard preformed interior corner rein¬forcement made from 2.5 lb./sq. yd. diamond mesh lath.

C. Aluminum Components: Alloy, temper, and finish recommended by manufacturer with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) or alloy and temper 6063-T5.

2.4 2.4 PORTLAND CEMENT PLASTER MATERIALS AND MIXES

A. Base Coat Materials:

1. Portland Cement: ASTM C 150, Type I.
2. Masonry Cement: ASTM C 91, Type N.
3. Lime: ASTM C 206, Type S special finishing hydrate.
4. Sand Aggregate: ASTM C 897.
5. Fiber for Base Coat: Alkaline resistant glass fibers, 1/2" long, free of contaminants, manufactured for use in portland cement plaster. Subject to compliance with requirements, provide "Dur O Fiber AR Glass" manufactured by Dur O Wal, Inc.

B. Finish Coat Materials:

1. Factory Prepared Finish Coat: Manufacturer's standard product requiring addition of water only; white in color unless otherwise indicated. Subject to compliance with requirements, provide "Oriental Exterior Finish Stucco" manufactured by United States Gypsum Company.
2. Portland Cement: ASTM C 150, Type I, white.
3. Lime: ASTM C 206, Type S special finishing hydrate.
4. Aggregate: ASTM C 897, manufactured or natural sand, white, or in color required to match Architect's accepted sample.

C. Portland Cement Plaster Mixes: Comply with ASTM C 926 for portland cement plaster base and finish coat mixes as applicable to plaster bases, materials, and other requirements indicated. Proportion materials for respective base coats in parts by volume for cementitious materials and in parts by volume per sum of cementi¬tious materials for aggregates to comply with the following requirements for each method of application and plaster base indicated. Adjust mix proportions below within limits specified to attain workability.

1. Scratch Coat: 1 part portland cement, 1 to 2 parts masonry cement, 2-1/2 to 4 parts sand.
2. Brown Coat: 1 part portland cement, 1 to 2 parts masonry cement, 3 to 5 parts sand.
3. Factory Prepared Portland Cement Finish Coat: Add water only; comply with finish coat manufacturer's directions.
4. Finish Coat: 1 part portland cement, 1-1/2 to 2 parts lime, 3 parts sand.
5. Scratch Coat: 1 part portland cement, 0 to 3/4 parts lime, 2-1/2 to 4 parts sand.
6. Brown Coat: 1 part portland cement, 0 to 3/4 parts lime, 3 to 5 parts sand.
7. Finish Coat: 1 part portland cement, 3/4 to 1-1/2 parts lime, 3 parts sand.
8. Scratch Coat: 1 part portland cement, 3/4 to 1-1/2 parts lime, 2-1/2 to 4 parts sand.
9. Brown Coat: 1 part portland cement, 3/4 to 1-1/2 parts lime, 3 to 5 parts sand.

10. Finish Coat: 1 part portland cement, 1 part masonry cement, 3 parts sand.

11. Fiber Content: Add fiber to scratch and brown coats above to comply with fiber manufacturer's directions but not to exceed 2 lbs./cu. ft. of cementitious materials. Reduce aggregate quantities accordingly to maintain workability.

1.01.1.1.10.1 GYPSUM PLASTER MATERIALS AND MIXES

D. Base Coat Plaster Materials:

1. Gypsum neat plaster complying with ASTM C 28. Subject to compliance with requirements, provide one of the following:

   a. Red Top Gypsum Plaster; United States Gypsum Co.

   b. Red Top Two Purpose Plaster; United States Gypsum Co.

   c. Two Way Hardwall Plaster; Gold Bond Building Products Division, National Gypsum Co.

1.01.1.1.10.1.1 Gypsum wood fibered plaster complying with ASTM C 28. Subject to compliance with requirements, provide one of the following:

d. Red Top Wood Fiber Plaster; United States Gypsum Co.

1.01.1.1.10.1.2 Gypsum ready mixed plaster, with mill mixed perlite aggregate, and complying with ASTM C 28. Subject to compliance with requirements, provide one of the following:

e. Gypsolite; Gold Bond Building Products Division, National Gypsum Co.

f. Structo Lite; United States Gypsum Co.

1.01.1.1.10.1.3 High strength gypsum gauging plaster complying with ASTM C 28 and with a minimum average dry compressive strength of 2,800 psi per ASTM C 472 for a mix of 100 lbs. plaster and 2 cu. ft. of sand. Subject to compliance with requirements, provide one of the following:

g. Structo Base: United States Gypsum Co.

1.01.1.1.10.1.4 Aggregate: ASTM C 35, type as indicated below.

h. Sand aggregate, unless otherwise indicated.

i. Perlite aggregate where indicated.

E. Finish Coat Plaster Materials:

1. Gypsum gauging plaster complying with ASTM C 28. Subject to compliance with requirements, provide one of the following:

   a. Champion Gauging Plaster; United States Gypsum Co.

   b. Red Top Gypsum Plaster; United States Gypsum Co.

   c. Star Gauging Plaster; United States Gypsum Co.

   d. Super White Gauging Plaster; Gold Bond Building Products Division, National Gypsum Co.

1.01.1.1.10.1.5 Gypsum ready mixed finished plaster, manufacturer's standard mill mixed gauged interior finish. Subject to compliance with requirements, provide one of the following:

e. Red Top Finish; United States Gypsum Co.

1.01.1.1.10.1.6 High strength gypsum gauging plaster complying with ASTM C 28, with a minimum average dry compressive strength of 5,000 psi per ASTM C 472 for a neat mix. Subject to compliance with requirements, provide one of the following:

f. Structo Base; United States Gypsum Co.

1.01.1.1.10.1.7 Gypsum Keene's cement complying with ASTM C 61. Subject to compliance with requirements, provide one of the following:

g. Red Top Keene's Cement; United States Gypsum Co.

1.01.1.1.10.1.8 Gypsum casting and molding plaster complying with ASTM C 59, in color as selected by Architect from manufacturer's standard white and grey colors. Subject to compliance with requirements, provide one of the following:

h. Super White Molding Plaster; Gold Bond Building Products Division, National Gypsum Co.

i. USG Molding Plaster; United States Gypsum Co.

1.01.1.1.10.1.9 Finishing hydrated lime complying with ASTM C 206, Type S, special finishing hydrate. Subject to compliance with requirements, provide one of the following:

j. Ivory Finish Lime; United States Gypsum Co.

k. Snowdrift Finish Lime; United States Gypsum Co.

1.01.1.1.10.1.10 Aggregates for Finish Coat Plaster with Floated Finish: ASTM C 35; graded per ASTM C 842, type as indicated below:

l. Sand aggregate.

m. Perlite aggregate.

n. Sand aggregate, except perlite over base coats containing perlite aggregate.

F. Gypsum Plaster Mixes: Comply with ASTM C 842 and manufacturer's directions for base coat and finish coat proportions and finish coat textures indicated below:

1. Scratch Coat: Gypsum wood fibered plaster, neat or with job mixed sand.
2. Brown Coat: Gypsum neat plaster with job mixed sand.
3. Finish Coat: Trowel finish gypsum ready mix finish plaster; neat.
4. Scratch Coat: Gypsum wood fibered plaster, neat or with job mixed sand.
5. Brown Coat: Gypsum wood fibered plaster with job mixed sand.
6. Finish Coat: Float finished gypsum gauging plaster; 1 part plaster, 2 parts lime, 8 parts sand.
7. Scratch Coat: Gypsum wood fibered plaster, neat or with job mixed sand.
8. Brown Coat: Gypsum neat plaster with job mixed perlite, or ready mix plaster with mill mixed perlite.
9. Finish Coat: Trowel finished gypsum gauging plaster; 1 part plaster and 2 parts lime.
    a. Over lightweight aggregate base coats, add 1/2 cu. ft. of perlite fines or 50 lbs. of No. 1 white silica sand per 100 lbs. of plaster.

1.01.1.1.10.1.11 Scratch and Brown Coat: High strength gypsum gauging plaster with job mixed sand.

10. Finish Coat: Trowel finished high strength gypsum gauging plaster; 1 part plaster to 1 part lime.
11. Scratch and Brown Coat: Gypsum neat plaster with job mixed sand.
12. Finish Coat: Trowel finished gypsum Keene's cement; 4 parts plaster to 1 part lime.

13. Finish Coat: Float finished gypsum Keene's cement; 2 parts plaster, 1 part lime, 8 parts sand.

1.01.1.1.10.2 MISCELLANEOUS MATERIALS

G. Water for Mixing and Finishing Plaster: Drinkable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

1.01.1.1.11 Bonding Compound for Gypsum Plaster: ASTM C 631.

H. Bonding Agent for Portland Cement Plaster: ASTM C 932.

1.01.1.1.12 Acoustical Sealant: ASTM C 919, nonoxidizing, skinning paintable types for exposed applications; nondrying, nonhardening, nonstaining, nonbleeding, gunnable type sealant complying with requirement specified in Division 7 Section "Joint Sealers" for concealed applications.

I. Sound Attenuation Blankets: Unfaced mineral fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (without membrane facing); of widths to fill completely void formed by framing members.

1.01.1.1.13 Flexible Flashing: Provide flexible flashing at perimeter of openings and penetrations as indicated. Provide flashing material designed specifically for use as wall flashing, consisting of a rubberized asphalt compound bonded to a polyethylene film with the following properties:

1. Thickness: 40 Mils

2. Color: Gray-Black

3. Roll Width: 18 inches and 36 inches.

4. Product: "Perm-A-Barrier Wall Flashing" by W. R. Grace & Co.

1.01.1.1.13.1 MIXING

J. Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.14 All installation shall be in accordance with manufacturer’s published recommendations.

3.2 INSTALLATION OF LATHING AND FURRING, GENERAL

A. Interior Lathing and Furring Installation Standard: Install lathing and furring materials indicated for gypsum plaster to comply with ASTM C 841.

1.01.1.1.15 Portland Cement Plaster Lathing and Furring Installation Standard: Install lathing and furring materials indicated for portland cement plaster to comply with ASTM C 1063.

B. Install supplementary framing, blocking, and bracing at terminations in the Work and for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar Work to comply with details indicated or, if not otherwise indicated, to comply with applicable published recommendations of gypsum plaster manufacturer or, if not available, of "Gypsum Construction Handbook" published by United States Gypsum Co.

1.01.1.1.16 Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall Work abuts overhead structure, isolate the Work from structural movement sufficiently to prevent transfer of loading into the Work from the building structure. Install slip or cushion type joints to absorb deflections but maintain lateral support.

   1. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

C. Install flexible flashing at locations indicated, following manufacturer's recommendations and details appropriate to the Project conditions.

   1. Properly prepare substrate to ensure adhesion of flashing sheet.
   2. Apply manufacturer's recommended primer to substrate and allow to dry for a minimum of 20 minutes prior to flashing application.
   3. Overlap adjoining pieces 1 inches to 2 inches and roll all overlaps with a steel roller.
   4. Apply a bead of mastic/sealant at top edge termination and at overlaps.

1.01.1.1.16.1 INSTALLATION OF CEILING SUSPENSION SYSTEMS

D. Preparation and Coordination: Coordinate installation of ceiling suspension system with installation of overhead structural systems to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling hangers in a manner that will develop their full strength and at spacings required to support ceiling.

   1. Furnish concrete inserts, and other devices indicated, to other trades for installations well in advance of time needed for coordination with other Work.

E. Hanger Installation: Attach hangers to structure above ceiling to comply with ML/SFA "Specifications for Metal Lathing and Furring" and with referenced standards.

   1. Do not attach hangers to metal deck tabs.

F. Install ceiling suspension system components of sizes and spacings indicated but not in smaller sizes or greater spacings than those required by referenced lathing and furring installation standards.

   1. Wire Hangers: Space 8 gage (0.16 inch diameter) wire hangers not over 4' 0" on center parallel with and not over 3' 0" perpendicular to direction of carrying channels, unless otherwise indicated, and within 6 inches of carrying channel ends.
   2. Carrying Channels: Space carrying channels not over 3' 0" on center with 4' 0" on center hanger spacing.
   3. Furring Channels to Receive Metal Lath: Space furring channels not over 16 inches on center for 3.4 lb. diamond mesh lath, 19 inches on center for 3.4 lb. flat rib lath, or 24 inches on center for 3.4 lb., 3/8 inch rib lath.
   4. Furring Channels to Receive Gypsum Lath: Space furring channels not over 16 inches on center for 3/8 inch thick, clip attached gypsum lath, unless closer spacing indicated or required for fire resistance rated assembly.

1.01.1.1.16.2 METAL LATHING

G. Install expanded metal lath for the following applications where plaster base coats are required. Provide appropriate type, configuration, and weight of metal lath selected from materials indicated that comply with referenced lathing installation standards.

   1. Suspended and furred ceilings using 3.4 lbs. per sq. yd. minimum weight diamond mesh lath.
   2. Vertical metal framing and furring.
   3. Ceramic tile setting beds using 3.4 lbs. per sq. yd. minimum weight diamond mesh lath.

4. Exterior sheathed wall surfaces using 3.4 lbs. per sq. yd. minimum weight self furring diamond mesh lath:

1.01.1.1.16.3 INSTALLATION OF PLASTERING ACCESSORIES

H. Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Miter or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and alignment during plastering.

1.01.1.1.17 Accessories for Gypsum Plaster: Provide the following types to comply with requirements indicated for location:

1. Corner Beads: Install at external corners.
2. Casing Beads: Install at terminations of plaster Work, except where plaster passes behind and is concealed by other Work and where metal screeds, bases, or metal frames and act casing beads.
3. Control Joints: Install at locations indicated, or if not indicated, at locations complying with the following criteria and accepted by Architect.
    a. Where a control joint occurs in surface of construction directly behind plaster membrane.
    b. Plaster Partitions: 30' feet on center
    c. Ceilings without Perimeter Relief: 30 feet on center
    d. Ceilings with Perimeter Relief: 50 feet on center

I. Accessories for Portland Cement Plaster: Provide the following types to comply with requirements indicated for location:

1. Corner Bead: Install at external corners.
2. Cornerite: Install at interior corners to comply with referenced standards.
3. Casing Beads: Install at terminations of plaster Work unless otherwise indicated. At small penetrations, such as columns and pipes, set casing beads ¾ inches from penetrating object.
4. Control Joints: Install control joints at locations indicated, or if not indicated, at locations complying with the following criteria and accepted by Architect.
    a. Where a control joint occurs in surface of construction directly behind plaster membrane.
    b. Where distance between control joints in plastered surface exceeds 10 feet in either direction.
    c. Where area within portland cement panels exceed 100 sq. ft.
    d. Where portland cement plaster panel sizes or dimensions change. Extend joints full width or height of plaster membrane.

1.01.1.1.17.1.1 Expansion Joints: Install expansion joints at locations indicated or, if not indicated, at locations complying with the following criteria and approved by Architect.

e. Where an expansion or control joint occurs in surface of construction directly behind plaster membrane.

f. Horizontally, within 4 inches of a floor line directly behind plaster Work.

g. Vertically, at all column lines directly behind plaster Work.

h. Changes from insulated to uninsulated back up construction.

i. Changes in type of back up construction.

j. Set beads ¼ inches apart for interior Work and ½ inches apart for exterior Work.

3.3 PLASTER APPLICATION, GENERAL

A. Prepare monolithic surfaces for bonded base coats and use bonding compound or agent to comply with requirements of referenced plaster application standards for conditioning of monolithic surfaces.

1.01.1.1.18 Tolerances: Do not deviate more than 1/8 inch in 10' 0" from a true plane in finished plaster surfaces, as measured by a 10' 0" straightedge placed at any location on surface.

B. Grout hollow metal frames, bases, and similar Work occurring in gypsum plastered areas, with base coat plaster material and prior to lathing where necessary. Except where full grouting is indicated or required for fire resistance rating, grout at least 6 inches at each jamb anchor clip.

1.01.1.1.19 Sequence plaster application with the installation and protection of other Work so that neither will be damaged by the installation of the other.

C. Plaster flush with metal frames and other built in metal items or accessories that act as a plaster ground, unless otherwise indicated. Where plaster is not terminated at metal by casing beads, cut base coat free from metal before plaster sets and groove finish coat at the junctures with metal.

1.01.1.1.20 Apply thicknesses and number of coats of plaster as indicated or as required by referenced standards.

D. Concealed Plaster: Where plaster application will be concealed by wood paneling, above suspended ceilings and similar locations, finish coat may be omitted; where concealed behind cabinets and similar furnishings and equipment, apply finish coat; where used as a base for adhesive application of tile and similar finishes, omit finish coat and coordinate thickness with overall dimension as shown and comply with tolerances specified.

3.4 GYPSUM PLASTER APPLICATION

A. Interior Gypsum Plaster Application Standard: Apply gypsum plaster materials, composition, mixes, and finishes indicated to comply with ASTM C 842.

1. Use three coat work, ¾ inch thickness, over metal lath bases.
2. Use two coat work, 5/8 inch thickness, directly on unit masonry.
3. Finish Coat: Troweled finish for gypsum finish coat plasters to produce a smooth dense finish, unless otherwise indicated.
4. Finish Coat: Floated finish for gypsum plaster finish coats; match Architect's sample for texture and color.

B. Ornamental Plaster Applications: Run or cast the Work in place (or precast at Contractor's option) in accordance with the profile and relief requirements shown or accepted by models or mock ups (if any). At corners of running moldings and cornices, miter the Work to produce symmetric treatment running both ways from each corner.

3.5 PORTLAND CEMENT PLASTER APPLICATION

A. Apply portland cement plaster materials, compositions, and mixes to comply with ASTM C 926.

1. Use three coat work, 7/8 inch thickness, over metal lath bases.
2. Use two coat work, 5/8 inch thickness, directly on unit masonry.

3. Finish Coat: Floated finish unless otherwise indicated; match Architect's sample for texture and color.

4. Finish Coat: Dash finish, machine applied to match Architect's accepted sample.

B. Moist cure portland cement plaster base and finish coats to comply with ASTM C 926, including recommendations for time between coats and curing in "Annex A2 Design Considerations."

3.6 CUTTING AND PATCHING

A. Cut, patch, point up, and repair plaster as necessary to accommodate other Work and to restore cracks, dents, and imperfections. Repair or replace Work to eliminate blisters, buckles, excessive crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to the substrate has failed.

1.01.1.1.21 Sand smooth troweled finishes lightly to remove trowel marks and arrises.

3.7 CLEANING AND PROTECTION

A. Remove temporary protection and enclosure of other Work. Promptly remove plaster from door frames, windows, and other surfaces that are not to be plastered. Repair floors, walls, and other surfaces that have been stained, marred, or otherwise damaged during the plastering Work. When plastering Work is completed, remove unused materials, containers, and equipment and clean floors of plaster debris.

1.01.1.1.22 Provide final protection and maintain conditions, in a manner suitable to Installer that ensure plaster Work's being without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 21 00 00

SECTION 09 22 00 00 - SUPPORTS FOR PLASTER AND GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Fire Resistance Ratings: Where indicated, provide materials and construction which are identical to those of assemblies whose fire resistance rating has been determined per ASTM E 119 by a testing and inspecting organization acceptable to authorities having jurisdiction.

1. Provide fire resistance rated assemblies identical to those indicated by reference to GA File No's. in GA 600 "Fire Resistance Design Manual" or to design designations in U.L. "Fire Resistance Directory" or in listing of other testing and agencies acceptable to authorities having jurisdiction.

1.4 SUBMITTALS

A. Product Data:

1. Submit product data consisting of manufacturer's product Specifications and installation instructions for each product, including data showing compliance with the requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 Manufacturers

A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include:

1. Alabama Metal Industries (AMICO)

2. Dale/Incor Inc.

3. Delta Metal Products

4. Dietrich Industries Inc.

5. Marino Industries Corp.

6. Unimast Co.

2.3 STEEL FRAMING FOR WALLS AND PARTITIONS

A. Design Criteria: Design metal stud partitions to have deflection not to exceed l/240 under a 5 psf lateral load. Where height of stud required exceeds the deflection criteria shown in manufacturer's printed engineering charts, provide heavier gauge studs, or closer spacing, as required for actual span conditions.

B. Steel Studs and Runners: ASTM C 645, with flange edges of studs bent back 90 degrees and doubled over to form 3/16 inch minimum lip (return) and complying with the following requirements for minimum thickness and depth:

1. Thickness: 0.0329 inch (20 gauge), unless otherwise indicated.

2. Thickness: 0.0179 inch (25 gauge) where indicated.

3. Thickness: 0.0270 inch (22 gauge) where indicated.

4. Thickness: As indicated.

5. Depth: 3-5/8 inches, unless otherwise indicated.

6. Depth: 6 inches where indicated.

7. Depth: 4 inches where indicated.

8. Depth: 2-1/2 inches where indicated.

9. Depth: 1-5/8 inches where indicated.

10. Depth: As indicated.

1.01.1.1.1.1 Steel Rigid Furring Channels: ASTM C 645, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:

11. Depth: 7/8 inch.

12. Depth: 1-1/2 inch.

13. Thickness: 0.0329 inch (20 gauge), unless otherwise indicated.

14. Thickness: 0.0179 inch (25 gauge) where indicated.

15. Thickness: 0.0270 inch (22 gauge) where indicated.

16. Thickness: As indicated.

1.01.1.1.1.2 Furring Brackets: Serrated arm type, adjustable, fabricated from corrosion resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.0329 inch, designed for screw attachment to steel studs and steel rigid furring channels used for furring.

C. Steel Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission, complying with ASTM C 645 for base metal, finish and widths of face and fastening flange, fabricated to form 1/2 inch deep channel of the following configuration:

1. Single Leg Configuration: Asymmetric-shaped channel with a face connected to a single flange by a single slotted leg (web).

2. Double Leg Configuration: Hat shaped channel, with 1-1/2 inch wide face connected to flanges by double slotted or expanded metal legs (webs).

3. Configuration: Either one indicated above.

1.01.1.1.1.3 Z Furring Members: Manufacturer's standard zee shaped furring members with slotted or nonslotted web, fabricated from hot dip galvanized steel sheet complying with ASTM A 525, Coating Designation G60; with a minimum base metal (uncoated) thickness of 0.0179 inch, face flange of 1-1/4 inch, wall attachment flange of 7/8 inch, and of depth required to fit insulation thickness indicated.

D. Fasteners: Provide fasteners of type, material, size, corrosion resistance, holding power and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum drywall manufacturers for applications indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.2 INSTALLATION OF STEEL FRAMING, GENERAL

A. Steel Framing Installation Standard: Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation.

1. Steel Stud Systems to Receive Metal Lath: Comply with requirements of ML/SFA 920, "Guide" "Specifications for Metal Lathing and Furring" applicable to each installation condition and type of metal stud system indicated.

1.01.1.1.1.4 Install supplementary framing, blocking and bracing at terminations in the Work and for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar construction to comply with details indicated and with recommendations of gypsum board manufacturer, or if none available, with "Gypsum Construction Handbook" published by United States Gypsum Co.

B. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement, at locations indicated below to comply with details shown on Drawings:

1. Where edges of suspended ceilings abut building structure horizontally at ceiling perimeters or penetration of structural elements.

2. Where partition and wall framing abuts overhead structure.

    a. Provide slip or cushioned type joints as detailed to attain lateral support and avoid axial loading.

C. Do not bridge building expansion and control joints with steel framing or furring members; independently frame both sides of joints with framing or furring members or as indicated.

3.3 INSTALLATION OF STEEL FRAMING FOR FURRED CEILINGS AND SOFFITS

A. Screw furring members to wood framing.

B. Secure hangers to structural support by connecting directly to structure where possible, otherwise connect to cast in concrete inserts or other anchorage devices or fasteners as indicated.

C. Do not connect or suspend steel framing from ducts, pipes or conduit.

D. Keep hangers and braces two inches clear of ducts, pipes and conduits.

E. Sway brace suspended steel framing with hangers used for support.

F. Install suspended steel framing components in sizes and at spacings indicated but not less than that required by referenced steel framing installation standard.

G. For exterior soffits provide cross bracing and additional framing indicated or required to resist wind uplift.

3.4 INSTALLATION OF STEEL FRAMING FOR WALLS AND PARTITIONS

A. Install runners (tracks) at floors, ceilings and structural walls and columns where gypsum drywall stud system abuts other construction.

   1. Where studs are installed directly against exterior walls, install asphalt felt strips between studs and wall.

1.01.1.1.1.5 Installation Tolerances: Install each steel framing and furring member so that fastening surface do not vary more than 1/8 inch from plane of faces of adjacent framing.

B. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

C. Terminate partition framing at suspended ceilings where indicated.

D. Install steel studs and furring in sizes and at spacings indicated but not less than that required by referenced steel framing installation standard.

   1. For single layer construction: Unless otherwise indicated, 16 inches on center.

1.01.1.1.1.6 Install steel studs so that flanges point in the same direction and gypsum boards can be installed in the direction opposite to that of the flange.

E. Frame door openings to comply with details indicated, with GA 219 and with applicable published recommendations of gypsum board manufacturer. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

F. Frame openings other than door openings to comply with details indicated, or if none indicated, in same manner as required for door openings; and install framing below sills of openings to match framing required above door heads.

END OF SECTION 09 22 00 00

SECTION 09 29 00 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 definitions

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA 505 for definitions of terms for gypsum board construction not otherwise defined in this section or other referenced standards.

1.4 QUALITY ASSURANCE

A. Fire Resistance Ratings: Where indicated, provide materials and construction which are identical to those of assemblies whose fire resistance rating has been determined per ASTM E 119 by a testing and inspecting organization acceptable to authorities having jurisdiction.

1. Provide fire resistance rated assemblies identical to those indicated by reference to GA File No's. in GA 600 "Fire Resistance Design Manual" or to design designations in U.L. "Fire Resistance Directory" or in listing of other testing and agencies acceptable to authorities having jurisdiction.

B. Perform gypsum board Work in accordance with recommendations of ASTM C 754 an GA 216 unless otherwise indicated or required by project conditions.

1.01.1.1.3 Keep a copy of GA 216 and GA 600 in field office for duration of project.

C. Single Source Responsibility: Obtain each type of gypsum board and related joint treatment materials from a single manufacturer.

1.5 SUBMITTALS

A. Product Data:

1. Submit product data indicating compliance with all specified requirements.

B. Record Documents:

1. Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

2. Design Data: Submit copies of each UL design selected for each required fire resistance rating for gypsum drywall assemblies including installer certification that each UL design selected will provide the scheduled fire resistance rating in accordance with local Codes.

3. Submit certification and test results that clearly state and indicate that each individual element and component of fire rated gypsum drywall assemblies are approved and appropriately rated for specific rated assembly for which it is to be used, and that the use of such individual element will in no way jeopardize the required rating of the assembly.

4. Submit Shop Drawings including complete details indicating location of all control and expansion joints in walls and ceilings.

1.01.1.1.3.1 DELIVERY, STORAGE and HANDLING

C. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.

1.01.1.1.4 Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes. Neatly stack gypsum boards flat to prevent sagging.

D. Handle gypsum boards to prevent damage to edges, ends, and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.6 SEQUENCING AND SCHEDULING

A. Sequence installation of gypsum sheathing board with installation of exterior cladding to comply with requirements indicated below:

1. Do not leave gypsum sheathing board exposed to the weather after application for longer than one month.

2. Do not leave gypsum sheathing board exposed to weather after its application for more than one month or, if protected as indicated below, for more than 6 months:

   a. Protect cutouts, corners and joints in the sheathing by filling them with a flexible sealant at the time sheathing is applied.

   b. As an alternate to sealant application, cover exposed exterior surface of sheathing with building paper or air infiltration barrier. Anchor covering with metal lath securely fastened through sheathing to framing. Apply covering immediately after sheathing is installed.

1.7 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for application and finishing gypsum board to comply with ASTM C 840 and with gypsum board manufacturer's recommendations.

1.01.1.1.5 Minimum Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 degrees F (4 degrees C). For adhesive attachment and finishing of gypsum board maintain not less than 50 degrees F (10 degrees C) for 48 hours prior to application and continuously thereafter until drying is complete.

B. Ventilate building spaces to remove water not required for drying joint treatment materials. Avoid drafts during dry, hot weather to prevent materials form drying too rapidly.

1.8 ASSEMBLY PERFORMANCE REQUIREMENTS

A. Sound Transmission Characteristics: For gypsum board assemblies indicated to have STC ratings, provide materials and construction identical to those of assemblies whose STC ratings were determined per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing agency.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include the following:

1. Grid Suspension Systems:

a. Armstrong World Industries

b. Chicago Metallic Corp.

c. Worthington Steel Co.

d. USG Interiors

1.01.1.1.5.1.1 Gypsum Boards and Related Products:
e. Domtar Gypsum Co.

f. Georgia Pacific Corp.

g. Gold Bond Building Products Div., National Gypsum Co.

h. United States Gypsum Co.

2.3 STEEL FRAMING COMPONENTS FOR SUSPENDED AND FURRED CEILINGS

A. General: Provide components which comply with ASTM C 754 for materials and sizes, unless otherwise indicated.

1.01.1.1.6 Concrete Inserts: Inserts designed for attachment to concrete forms and for embedment in concrete, fabricated from corrosion resistant materials, with holes or loops for attachment of hanger wires and capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined from testing per ASTM E 488, conducted by an independent testing laboratory.
B. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.

1.01.1.1.7 Hanger Rods: Mild steel, zinc coated or protected with rust inhibitive paint.
C. Flat Hangers: Mild steel, zinc coated or protected with rust inhibitive paint.

1.01.1.1.8 Angle Type Hangers: Angles with legs not less than 7/8 inch wide, formed from 0.0635 inch thick galvanized steel sheet complying with ASTM A 446, Coating Designation G90, with bolted connections and 5/16 inch diameter bolts.
D. Channels: Cold rolled steel, 0.0598 inch minimum thickness of base (uncoated) metal and 7/16 inch wide flanges, protected with rust inhibitive paint, and as follows:

1. Carrying Channels: 2 inches deep, 590 lbs per 1000 feet, unless otherwise indicated.

2. Carrying Channels: 1-1/2 inch deep, 475 lbs per 1000 feet, unless otherwise indicated.

3. Furring Channels: 3/4 inch deep, 300 lbs per 1000 feet, unless otherwise indicated.

E. Grid Suspension System: ASTM C 645, manufacturer's standard grid suspension system composed of main beams and cross furring members which interlock to form a modular supporting network.

1. Non Fire Rated Direct Hung Suspended Drywall Furring System: ASTM C 63, heavy-duty, double web steel main and cross runners with 1-3/8 inch wide capped flange face for screw attachment, and channel type wall track at perimeter; Chicago Metallic "640 Furring System".

1.01.1.1.8.1 GYPSUM BOARD

F. Provide gypsum board of types indicated in maximum lengths available to minimize end to end joints.

   1. Provide gypsum board in thicknesses indicated, or if not otherwise indicated, in 5/8 inch thicknesses to comply with ASTM C 840 for application system and support spacing indicated.

G. Gypsum Wallboard: ASTM C 36, "Regular" for vertical surfaces, "Sag-Resistant for ceilings, and as follows:

   1. Type: Type X where required for fire-resistant rated assemblies.
   2. Type: Foil backed where indicated.
   3. Edges: Tapered.
   4. Thickness: 5/8 inch, unless otherwise indicated.
   5. Subject to compliance with requirements, products which may be incorporated in the Work where "Regular" gypsum wallboard is indicated include:
      a. "Gyprock Regular"; Domtar Gypsum Co.
      b. "GP Gypsum Board"; Georgia Pacific Corp.
      c. "Regular Gypsum Board"; Gold Bond Building Products Div., National Gypsum Co.
      d. "SHEETROCK Brand Gypsum Panels"; United States Gypsum Co.

      1.01.1.1.8.1.1 Subject to compliance with requirements, products which may be incorporated in the Work where "Type X" gypsum wallboard is indicated include:

      e. "Gyprock Fireguard 'C' Gypsum Board"; Domtar Gypsum Co.
      f. "Firestop Type C"; Georgia Pacific Corp.
      g. "Fire Shield G"; Gold Bond Building Products Div., National Gypsum Co.
      h. "SHEETROCK Brand FIRECODE 'C' Gypsum Panels"; United States Gypsum Co.

H. Gypsum Backing Board for Multi Layer Applications: ASTM C 442 or, where backing board is not available from manufacturer, gypsum wallboard, ASTM C 36, and as follows:

   1. Type: Type X for fire resistance rated assemblies.
   2. Edges: Manufacturer's standard.

I. Water Resistant Gypsum Backing Board: ASTM C 630, and as follows:

   1. Type: Regular, unless otherwise indicated.
   2. Type: Type X for fire resistance rated assemblies.
   3. Thickness: 5/8 inch, unless otherwise indicated.

1.01.1.1.8.2 SHAFT-WALL SYSTEM DESCRIPTION

J. Performance Requirements, General: Provide gypsum board shaft wall systems complying with performance requirements specified, as demonstrated by pretesting manufacturer's corresponding stock systems.

1.01.1.1.9 Fire Resistance Ratings: Where indicated, provide materials and construction which are identical to those of assemblies, including those incorporating elevator door and other framing, whose fire resistance has been determined per ASTM E 119 by a testing and inspecting organization acceptable to authorities having jurisdiction.

1. Provide fire resistance rated assemblies identical to those indicated by reference to GA File No.'s in GA 600 "Fire Resistance Design Manual" or to design designations in UL "Fire Resistance Directory" or in listings of other testing and inspecting agencies acceptable to authorities having jurisdiction.

K. Steel Framing: ASTM C 645, of profile, size, and base metal thickness required to produce assemblies complying with structural performance requirements, with sectional properties computed to conform with AISI "Specification for Design of Cold Formed Steel Structural Members."

1.01.1.1.10 Gypsum Shaftwall Board: ASTM C 442, Type X liner panel or coreboard designed for shaft wall construction, with moisture resistant paper facings.

L. Structural Performance Characteristics: Provide gypsum board shaft wall systems engineered to withstand the following lateral design loadings (air pressures), applied transiently and cyclically, for maximum heights of partitions required, within the following deflection limits, verified by pretesting for deflection characteristics:

1. Lateral Loading: 5 per square foot
2. Lateral Loading: 7.5 per square foot
3. Lateral Loading: 10 per square foot
4. Lateral Loading: 15 per square foot
5. Lateral Loading: As indicated but not less than 10 per square foot
6. Deflection Limit: 1/120 of partition height
7. Deflection Limit: 1/240 of partition height
8. Deflection Limit: 1/360 of partition height
9. Deflection Limit: As indicated but not more than 1/240 of partition height

M. Sound Attenuation Performance: Provide gypsum board shaft wall systems designed and pretested to achieve the following minimum ratings for sound transmission class (STC) per ASTM E 90.

1. STC Rating: 35
2. STC Rating: 39
3. STC Rating: 47
4. STC Rating: 50
5. STC Rating: As indicated but not less than 35

N. Cavity Shaft Wall Systems: Provide assemblies consisting of gypsum shaft wall boards inserted between U or J shaped metal floor and ceiling tracks; with specially shaped studs engaged in tracks and fitted between shaftwall boards; and gypsum boards on finished side or sides applied to studs in number of layers, thicknesses and arrangement indicated.

1. Shaftwall Board Thickness: As indicated.
2. Stud Shape: I, C H or double E
3. Stud Thickness: 0.0179 inch min. thickness of base metal unless otherwise indicated or required.
4. Stud Depth: As indicated.
5. Room Side Finish: As indicated.
6. Shaft Side Finish: One layer of gypsum board; provide only where finish is indicated on shaft side as well as room side, otherwise leave exposed.
7. Cavity Insulation: Provide sound attenuation blankets in cavity formed by studs between shaftwall board and room side finish.

1.01.1.1.10.1 GYPSUM SHEATHING AT EIFS SYSTEMS

O. Glass Mat Gypsum Board: Gypsum board designed as an exterior substrate for a weather barrier, consisting of a noncombustible water resistant core, essentially gypsum, surfaced with glass mats on face and back, partially or completely embedded in core, and with unsurfaced square edges. Comply with ASTM C 1177 and requirements indicated below:

1. Type: Regular unless Type X is required by Project conditions.
2. Thickness: 1/2 inch unless otherwise indicated.
3. Size: 4 feet by 8 feet

P. Product: Dens Glass Gold Exterior Sheathing, Georgia Pacific Corp.

2.4 GYPSUM SHEATHING AT ALL OTHER LOCATIONS

A. Gypsum Sheathing Board with Water Resistant Core: Gypsum sheathing board consisting of noncombustible gypsum core incorporating a water resistant material, surfaced on face, back and long edges with water repellent paper; complying with ASTM C 79 and requirements indicated below:

1. Type: Regular (not Type X)
2. Edge and End Configuration: V shaped tongue and groove long edges, square ends.
3. Thickness: 1/2 inch
4. Size: 2 feet by 8 feet

B. Subject to compliance with requirements, gypsum sheathing boards which may be incorporated in the Work include, but are not limited to, the following:

1. "Gyproc Gypsum Sheathing"; Domtar Gypsum Co.
2. "G P Gypsum Sheathing"; Georgia Pacific Corp.
3. "Gold Bond Gypsum Sheathing"; Gold Bond Building Products Div., National Gypsum Co.
4. USG Gypsum Sheathing; United States Gypsum Co.

C. Sheathing Tape: Tape specifically designed and manufactured to seal joints in gypsum sheathing against water and air infiltration, formulated with an adhesive that permanently bonds to gypsum sheathing substrates, and as indicated below:

1. Polyethylene backed SBS modified sheathing joint tape, 0.0020 inch thick membrane, 4 inch wide: Protecto Flash Building Tape by Protecto Wrap Company, Denver, Colorado.

2. Linerless polypropylene sheathing tape, 0.0027 inch thick, 2-1/2 inches wide, composed of oriented polyproplyene backing coated with permanent acrylic adhesive formulated to adhere to gypsum sheathing surfaces: No. 8086 Contractor Sheathing Tape, 3M Contractor Products.

3. Polyethylene tape, 0.025 inch thick, 3 inches wide, composed of polyethylene backing coated with synthetic rubber based adhesive: POLYKEN 612 Seam Seal Tape, Polyken Technologies.

1.01.1.1.10.2 TRIM ACCESSORIES

D. Cornerbead and Edge Trim for Interior Installation: Provide corner beads, edge trim and control joints which comply with ASTM C 1047 and requirements indicated below:

1. Material: Formed metal, plastic or metal combined with paper, with metal complying with the following requirement:

   a. Sheet steel zinc coated by hot dip process.

   b. Sheet steel coated with zinc by hot dip or electrolytic processes, or with aluminum.

   1.01.1.1.10.2.1 One Piece Control Joint: Formed with vee shaped slot per Fig. 1 in ASTM C 1047, with slot opening covered with removable strip.

E. Aluminum Edge Trim: Where indicated, provide manufacturer's standard extruded aluminum edge trim of profile shown or referenced by manufacturer's standard product designation, fabricated from aluminum alloy 6063 T5 complying with ASTM B 221, with clear anodized finish.

1. Manufacturer: Subject to compliance with requirements, provide aluminum accessories of one of the following:

   a. Fry Reglet Corp.

   b. Gordon, Inc.

   c. MM Systems, Inc.

F. Metal Cornerbead and Edge Trim for Exterior Ceilings: Comply with ASTM C 1047, formed from rolled zinc.

2.5 SHEATHING ACCESSORY MATERIALS

A. Air Infiltration Barrier: As follows:

1. Asphalt saturated organic felt complying with ASTM D 226, Type I (No. 15 asphalt felt), unperforated.

2. Plastic Sheet as indicated below:

   a. Polyethylene sheet formed by spinning continuous strands of fine high density polyethylene interconnected fibers and bonding them together by heat and pressure; and as follows:

      1) Thickness: 0.0061 inch thick

      2) Basic Weight: 8.81 lb per 1000 sq. ft. per ASTM D 646

3) Roll Widths and Lengths: 3 feet by 165 feet, 9 feet by 195 feet

4) Moisture Vapor Transmission Rate: 795.38 grams/sq. meter/24 hours per ASTM E 96, Procedure A.

5) Surface Burning Characteristics: Flame spread: 5; smoke developed: 10; per ASTM E 84.

6) Product: Subject to compliance with requirements, provide "Tyvek Housewrap" by Textile Fibers Department, Du Pont Company.

1.01.1.1.10.2.1.1 Nonwoven polymeric sheet with reinforced edges and center nailing strips for tear resistance, and as follows:

7) Thickness: 0.006 inch

8) Basic Weight: 9.37 lb per 1000 sq. feet per ASTM D 646

9) Roll Widths and Lengths: 3 feet, 4' 6" feet, 8 feet, and 9 feet widths, 195 feet long.

10) Moisture Vapor Transmission Rate: 393.40 grams/sq. meter/24 hours per ASTM E 96, Procedure A.

11) Air Leakage Rate: 0.60 CFM at pressure differential of 1.56 psf, 1.12 CFM at pressure differential when tested as part of a fiber board sheathed wall assembly per ASTM E 283.

12) Surface Burning Characteristics: Flame spread of 0, smoke developed 45, per ASTM E 84.

13) Product: Subject to compliance with requirements, provide "Barricade Building Wrap" by Simplex Products Division, Anthony Industries, Inc.

B. Fasteners: Type S steel drill screws, 1 inch long, with corrosion resistant finish in form of cadmium plating or proprietary coating, and as follows:

1. For attachment of sheathing to light gage steel framing of less than 0.033 of an inch in thickness, provide steel drill screws complying with ASTM C 1002.

2. For attachment of sheathing to steel framing from 0.033 to 0.112 of an inch in thickness, provide steel drill screws complying with ASTM C 954.

C. Sealant: Solvent release curing joint sealant compatible with joint substrates formed by gypsum sheathing and other related materials and complying with requirements of Division 07 Section "Joint Sealers."

2.6 GYPSUM BOARD JOINT TREATMENT MATERIALS

A. Provide materials complying with ASTM C 475, ASTM C 840, and recommendations of manufacturer of both gypsum board and joint treatment materials for the application indicated.

2.7 MISCELLANEOUS MATERIALS

A. Provide auxiliary materials for gypsum drywall construction which comply with referenced standards and the recommendations of the manufacturer of the gypsum board.

1.01.1.1.11 Laminating Adhesive: Special adhesive or joint compound recommended for laminating gypsum boards.

B. Spot Grout: ASTM C 475, setting type joint compound of type recommended for spot grouting hollow metal door frames.

1.01.1.1.12 Fastening Adhesive for Wood: ASTM C 557

C. Fastening Adhesive for Metal: Special adhesive recommended for laminating gypsum boards to steel framing.

1.01.1.1.13 Gypsum Board Screws: ASTM C 1002

D. Gypsum Board Nails: ASTM C 514

1.01.1.1.14 Asphalt Felt: ASTM D 226, Type I (No. 15)

E. Concealed Acoustical Sealant: Nondrying, nonhardening, nonskinning, nonstaining, nonbleeding, gunnable sealant complying with requirement specified in Division 07 section "Joint Sealers."

1.01.1.1.15 Sound Attenuation Blankets: Unfaced mineral fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing); and as follows:

1. Mineral Fiber Type: Fibers manufactured from glass or slag.

   a. Owens Corning Fiberglas "Firecore 60 Sound Attenuation Batts"

   b. U. S. Gypsum Co. "Thermafiber Sound Attenuation Fire Blankets".

   1.01.1.1.15.1.1 Provide blankets in thicknesses shown or, if not shown, in manufacturer's standard nominal thickness corresponding to the wall stud width.

F. Sound Pads: Flat sheets of heavy, mastic, flexible, non-hardening material such as "Sound Pad #68" manufactured by L. H. Dottie Compnay.

1.01.1.1.16 Security Mesh: ¾ inch x 16 gage, flatten.

G. Vapor Retarder: Two outer layers of polyethylene film and one inner layer of nylon reinforcing, with an overall thickness of 6.0 to 8.0 mils.

1.01.1.1.17 Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either a nonwoven grid of nylon cord of polyester scrim and weighing not less than 26 lb/1000 sq. ft. (13 kg/100 sq.m), with maximum permeance rating of 0.0403 perm (2.3 ng/PA x s x sq. m) and flame-spread and smoke-developed indicates of not more than 5 and 75, respectively.

1. Subject to compliance with requirements, products that may be incorporated in the Work include:

2. Reinforced Polyethylene Vapor Retarder: "Griffolyn T 65," Griffolyn Div., Reef Industries, Inc.

3. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: Griffolyn T-55 FR; Reef Industries, Inc. Griffolyn Div.

H. Tape for Vapor Retarder: Pressure sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine substrates to which drywall construction attaches or abuts, preset hollow metal frames, cast in anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of drywall construction. Do not proceed with installation until unsatisfactory conditions have been corrected.

1.01.1.1.18 Ceiling Anchorages: Coordinate installation of ceiling suspension system with installation of overhead structural systems to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling anchors in a manner that will develop their full strength and at spacing required to support ceiling.

1. Furnish concrete inserts and other devices indicated, to other trades for installation well in advance of time needed for coordination with other construction.

B. Before sprayed on fireproofing is applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed on fireproofing. Where offset anchor plates are required provide continuous units fastened to building structure not more than 24 inches on center and to ceiling runners.

1.01.1.1.19 After sprayed on fireproofing has been applied, remove only as much fireproofing as needed to complete installation of drywall construction. Protect fireproofing that remains from damage.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.20 All installation shall be in accordance with manufacturer’s published recommendations.

3.3 INSTALLATION OF STEEL FRAMING FOR SUSPENDED CEILINGS

A. Install suspended steel framing components in sizes and at spacings indicated but not less than that required by referenced steel framing installation standard.

1.01.1.1.21 Suspend ceiling hangers from building structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

3. Secure wire hangers by looping and wire tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

4. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

5. Do not support ceilings directly from permanent metal forms. Furnish cast in place hanger inserts that extend through forms.

6. Do not attach hangers to steel deck tabs.

7. Do not attach hangers to steel roof deck. Attach hangers to structural members.

8. Do not connect or suspend steel framing from ducts, pipes or conduit.

B. Sway brace suspended steel framing with hangers used for support.

1.01.1.1.22 Installation Tolerances: Install steel framing components for suspended ceilings so that cross furring members or grid suspension members are level to within 1/8 inch in 12 feet as measured both lengthwise on each member and transversely between parallel members.

C. Wire tie or clip furring members to main runners and to other structural supports as indicated.

1.01.1.1.23 Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross furring members to each other and butt cut to fit into wall track.

3.4 APPLICATION AND FINISHING OF GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standard: Install and finish gypsum board to comply with ASTM C 840 and GA 216.

1.01.1.1.24 Install polyethylene vapor retarder on interior of framing members of exterior insulated walls to comply with the following requirements:

1. Extend vapor retarder to extremities of exterior insulated walls and to cover miscellaneous voids in insulated substrates, including those which have been stuffed with loose thermal insulation.

2. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners 16 inches on center.

3. Seal joints in vapor retarder caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with cloth or aluminized tape which bonds permanently to vapor retarder.

4. Repair tears or punctures in vapor retarder immediately before concealment by application of gypsum board or other construction.

B. Install sound attenuation blankets where indicated, prior to gypsum board unless readily installed after board has been installed.

1. Install sound pad sheets on the back of any device or accessory that is mounted in a drywall partition shown on Drawings to have an STC rating. Devices and accessories include: electrical receptacles, electrical outlet boxes, toilet accessories, and medical gas outlets.

C. Locate exposed end butt joints as far from center of walls and ceilings as possible, and stagger not less than 24 inches in alternate courses of board.

1.01.1.1.25 Install ceiling boards across framing in the manner which minimizes the number of end butt joints, and which avoids end joints in the central area of each ceiling. Stagger end joints at least 24 inches.

D. Install wall/partition boards in manner which minimizes the number of end butt joints or avoids them entirely where possible. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs.

1.01.1.1.26 Install exposed gypsum board with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1/16 inch open space between boards. Do not force into place.

E. Locate either edge or end joints over supports, except in horizontal applications where intermediate supports or gypsum board back blocking is provided behind end joints. Position boards so that like edges abut, tapered edges against tapered edges and mill cut or field cut ends against mill cut or field cut ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions.

1.01.1.1.27 Attach gypsum board to steel studs so that leading edge or end of each board is attached to open (unsupported) edge of stud flange first.

F. Attach gypsum board to supplementary framing and blocking provided for additional support at openings and cutouts.

1.01.1.1.28 Spot grout hollow metal door frames for solid core wood doors, hollow metal doors and doors over 32 inches wide. Apply spot grout at each jamb anchor clip just before inserting board into frame.

G. Form control joints and expansion joints at locations indicated, with space between edges of boards, prepared to receive trim accessories.

1.01.1.1.29 Cover both faces of steel stud partition framing with gypsum board in concealed spaces (above ceilings, etc.), except in chase walls which are braced internally.

1. Except where concealed application is indicated or required for sound, fire, air or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. area, and may be limited to not less than 75 percent of full coverage.
2. Fit gypsum board around ducts, pipes, and conduits.
3. Where partitions intersect open concrete coffers, cut gypsum board to fit profile of coffers and allow 1/4 to 1/2 inch wide joint for sealant.

H. Isolate perimeter of non load bearing drywall partitions at structural abutments. Provide 1/4 inch to 1/2 inch space and trim edge with "U" bead edge trim. Seal joints with acoustical sealant.

1.01.1.1.30 Where sound rated drywall construction is indicated, seal construction at perimeters, control and expansion joints, openings and penetrations with a continuous bead of acoustical sealant including a bead at both faces of partitions. Comply with ASTM C 919 and manufacturer's recommendations for location of edge trim, and close off sound flanking paths around or through construction, including sealing of partitions above acoustical ceilings.

1. For double layer partition systems, construction above acoustical ceilings may be installed with base layer only.

I. Space fasteners in gypsum boards in accordance with referenced gypsum board application and finishing standard and manufacturer's recommendations.

3.5 METHODS OF GYPSUM BOARD APPLICATION

A. Single Layer Application: Install gypsum wallboard as follows:

1. On ceilings apply gypsum board prior to wall/partition board application to the greatest extent possible.
2. On partitions/walls apply gypsum board vertically (parallel to framing), unless otherwise indicated, and provide sheet lengths which will minimize end joints.
3. On Z furring members apply gypsum board vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

B. Wall Tile Base: Where drywall is base for thin set ceramic tile and similar rigid applied wall finishes, install gypsum backing board.

1. In "dry" areas install gypsum backing board or wallboard with tapered edges taped and finished to produce a flat surface.

C. At showers, tubs and similar "wet areas" install glass mesh mortar units and treat joints to comply with ANSI A108.11 and manufacturer's recommendations for type of application indicated.

1.01.1.1.31 Double Layer Application: Install gypsum backing board for base layer and gypsum wallboard for face layer.

1. On ceilings apply base layer prior to application of base layer on walls/partitions; apply face layers in same sequence. Offset joints between layers at least 10 inches. Apply base layers at right angles to supports unless otherwise indicated.
2. On partitions/walls apply base layer and face layers vertically (parallel to framing) with joints of base layer over supports and face layer joints offset at least 10 inches with base layer joints.

3. On Z furring members apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

D. Acoustical Tile Base: Where drywall is base for adhesively applied acoustical tile, install gypsum backing board.

1. Provide either V joint type backing board or tape and finish joints to produce a flat surface.

E. Single Layer Fastening Methods: Apply gypsum boards to supports as follows:

1. Fasten with screws.

2. Fasten to steel framing with adhesive and supplementary screws.

3. Fasten to wood supports with single nailing.

4. Fasten to wood supports with double nailing.

5. Fasten to wood supports with adhesive and supplementary nails or screws.

F. Double Layer Fastening Methods: Apply base layer of gypsum board and face layer to base layer as follows:

1. Fasten both base layers and face layers separately to supports with screws.

2. Fasten base layers with screws and face layer with adhesive and supplementary fasteners.

3. Fasten base layers to wood supports with nails and face layer with adhesive and supplementary fasteners.

G. Direct Bonding to Substrate: Where gypsum board is indicated to be directly adhered to a substrate (other than studs, joists, furring members or base layer of gypsum board), comply with gypsum board manufacturer's recommendations, and temporarily brace or fasten gypsum board until fastening adhesive has set.

1.01.1.1.32 Exterior Soffits and Ceilings: Apply exterior gypsum soffit board perpendicular to supports, with end joints staggered over supports. Install with 1/4 inch open space where boards abut other construction.
1. Fasten with cadmium plated screws, or with galvanized or aluminum nails where supports are nailable.

1.01.1.1.32.1 INSTALLATION OF DRYWALL TRIM ACCESSORIES
H. General: Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges to comply with manufacturer's recommendations.

1.01.1.1.33 Install corner beads at external corners.
I. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi exposed, and except where plastic trim is indicated. Provide type with face flange to receive joint compound except where "U" bead (semi finishing type) is indicated.

1.01.1.1.34 Install U bead where indicated, and where exterior gypsum board edges are not covered by applied moldings or indicated to receive edge trim with face flanges covered with joint compound.
J. Install plastic edge trim where indicated on wall panels at juncture with ceilings.

1.01.1.1.35 Install control joints at locations indicated, or if not indicated, at spacings and locations required by referenced gypsum board application and finish standard, and approved by the Architect for visual effect.

1. Extend control joints for full height and width of gypsum board installation. Do not stop joints short of termination of gypsum board.

K. Install H molding in exterior gypsum drywall construction where control joints are indicated.

3.6 FINISHING OF DRYWALL

A. General: Apply joint treatment at gypsum board joints (both directions); flanges of corner bead, edge trim, and control joints; penetrations; fastener heads, surface defects and elsewhere as required to prepare Work for decoration.

1.01.1.1.36 Prefill open joints and rounded or beveled edges, if any, using setting type joint compound.

B. Apply joint tape at joints between gypsum boards, except where trim accessories are indicated.

1.01.1.1.37 Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA 214.

1. Level 1 for ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire resistive rated assemblies and sound rated assemblies.

2. Level 2 where water resistant gypsum backing board panels form substrates for tile, and where indicated.

3. Level 3 for gypsum board surfaces indicated to receive medium or heavy textured finishes before painting.

4. Level 4 for gypsum board surfaces indicated to receive light textured finishes, wallcoverings, and flat paints over light textures.

5. Level 5 for gypsum board surfaces indicated to receive gloss and semigloss enamels, nontextured flat paints, and where indicated.

C. Finish exterior gypsum soffit board by using setting type joint compounds to prefill joints, embed tape, and to apply first, fill (second) and finish (third) coats; smooth each coat before joint compound hardens to minimize need for sanding; sand between coats and after finish coat.

1.01.1.1.38 Base for Acoustical Tile: Where gypsum board is indicated as a base for adhesively applied acoustical tile, install tape and 2 coat compound treatment, without sanding.

D. Water Resistant Gypsum Backing Board Base for Ceramic Tile: Comply with ASTM C 840 and manufacturer's recommendations for treatment of joints behind tile.

1.01.1.1.39 Water Resistant Backing Board Base for Ceramic Tile: Finish joints between water resistant backing board with tape and setting type joint compound to comply with gypsum board manufacturer's recommendations and installation standards referenced in Division 9 Section "Tile."

E. Partial Finishing: Omit third coat and sanding on concealed drywall construction which is indicated for drywall finishing or which requires finishing to achieve fire resistance rating, sound rating or to act as air or smoke barrier.

1.01.1.1.40 At all corridor partitions, smoke-stop partitions, horizontal exit enclosures, and fire walls, permanently mark both sides of wall construction above ceilings to identify wall construction.

1. Label each wall with the words "(number) HOUR (FIRE) (SMOKE) Barrier - Do Not Penetrate".

2. Use stencils and paint letters at least 3 inches high in red ink or sign paint.

3. Apply to partition between 12 inches and 24 inches above ceiling line, located on surfaces that will not be concealed from view by subsequent construction.

4. For walls in excess of 20 feet long, message repeated every 20 feet unless otherwise required by applicable code. For walls less than 20 feet in length, label each wall.

5. Use vertical bold black lines with arrows designating areas of individual walls that have different ratings.

1.01.1.1.40.1 INSTALLATION OF GYPSUM BOARD SHAFT WALL SYSTEMS

F. General: Install gypsum board shaft wall systems to comply with performance and other requirements indicated as well as with manufacturer's installation instructions and the following:

1. ASTM C 754 for installation of steel framing.

G. Do not bridge building expansion joints with shaft wall system, frame both sides of joints with furring and other support as indicated.

1.01.1.1.41 Install supplementary framing, blocking and bracing to support gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings and similar Work which cannot be adequately supported directly by regular framing of gypsum board shaft wall system.

1. Support elevator hoistway door frames independently of shaft wall framing system, or reinforce system in accordance with system manufacturer's instructions.

2. Where handrails are indicated for direct attachment to gypsum board shaft wall system, provide not less than a 0.0341 inch thick by 4 inch wide galvanized steel reinforcement strip, accurately positioned and secured behind not less than one gypsum board face layer of 1/2 inch or 5/8 inch thickness.

H. Coordinate gypsum board shaft wall construction with sprayed on fireproofing of the structure, so that both remain complete and undamaged. Patch or replace sprayed on fireproofing removed or damaged during the installation of the shaft wall system.

1.01.1.1.42 Integrate stair hanger rods with gypsum board shaft wall system where indicated (and where possible); by locating cavity of system as required to enclose rods.

I. At penetrations in shaft wall, maintain fire resistance rating of entire shaft wall assembly by installing supplementary fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

1.01.1.1.43 Isolate shaft wall system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading. Comply with details shown and with manufacturer's instructions.

J. Seal gypsum board shaft walls at perimeter of each section which abuts other Work and at joints and penetrations within each section. Install acoustical sealant to withstand dislocation by air pressure differential between shaft and external spaces; comply with manufacturer's instructions and ASTM C 919.

1.01.1.1.44 In elevator shafts where gypsum board shaft wall system cannot be positioned within 2 inches of shaft face of structural beams, floor edges and similar projections into shaft, install 1/2 inch or 5/8 inch thick gypsum board cants covering tops of projections as follows:

1. Slope cant panels not more than 15 degrees from vertical. Set base edge of panels in gypsum board adhesive and secure top edges to shaft walls at 24 inches on center with screws fastened to shaft wall framing.

2. Where cants exceed 2 inches, support gypsum board with steel studs spaced 24 inches on center; extend studs from top of projection to shaft wall framing behind cant.

1.01.1.1.44.1 SHEATHING INSTALLATION

K. General: Except as otherwise indicated, comply with manufacturer's instructions, GA 253, and the following for the installation of gypsum sheathing.

1. Cut boards at penetrations, edges and other obstructions of the Work; fit tight against abutting Work, except provide 3/8 inch setback where non loadbearing Work abuts structural elements at head and jambs.

2. Coordinate installation of sheathing with installation of flashing and joint sealers so that these combined materials are installed in the sequence and manner which prevents exterior moisture from passing through completed exterior wall assembly to the interior.

3. Apply fasteners so that screw heads bear tightly against face of gypsum sheathing boards but do not cut into face paper.

4. Do not bridge building expansion joints with gypsum sheathing; cut and space edges to match spacing of structural support elements.

L. Horizontal Installation: Install 2 feet wide gypsum sheathing boards horizontally with V grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of stud flanges and stagger end joints of adjacent boards not less than one stud spacing, two where possible. Screw attach boards at perimeter and within field of board to each steel stud as follows:

1. Fasteners spaced approximately 8 inches on center and set back 3/8 inch minimum from edges and ends of boards.

2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self furring metal lath is screw attached through gypsum sheathing to studs immediately after installation of sheathing.

M. Air Infiltration Barrier Application: Cover gypsum board sheathing with air infiltration barrier as follows:

1. Cut back air infiltration barrier 1/2 inch on each side of break in supporting members at control joint locations.

2. Apply asphalt saturated organic felt horizontally with 2 inch overlap and 6 inch endlap; fasten to sheathing with corrosion resistant staples.

3. Apply plastic sheet to comply with manufacturer's printed directions.

4. Apply air infiltration barrier to cover upstanding flashing with 4 inch overlap.

1.01.1.1.44.2 APPLICATION OF TEXTURE FINISH

N. Surface Preparation and Primer: Prepare and prime drywall and other surfaces in strict accordance with texture finish manufacturer's instructions. Apply primer to all surfaces to achieve texture finish.

1.01.1.1.45 Finish Application: Mix and apply finish to drywall and other surfaces indicated to receive finish in strict accordance with manufacturer's instructions to produce a uniform texture matching Architect's sample (light broom finish) without starved spots or other evidence of thin application, and free of application patterns.

O. Remove any texture droppings or overspray from door frames, windows and other adjoining construction.

3.7 PROTECTION

A. Provide final protection and maintain conditions, in a manner suitable to Installer, which ensures gypsum drywall construction being without damage or deterioration at time of Substantial Completion.

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SECTION 09 31 00 00 - THIN-SET TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Single Source Responsibility for Tile: Obtain each color, grade, finish, type, composition, and variety of tile from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.01.1.1.3 Single Source Responsibility for Setting and Grouting Materials: Obtain ingredients of a uniform quality from one manufacturer for each cementitious and admixture component and from one source or producer for each aggregate.

B. Installer Qualifications: Engage an experienced Installer who has successfully completed tile installations similar in material, design, and extent to that indicated for Project.

1.01.1.1.4 Preinstallation Conference: Conduct conference at Project Site to comply with requirements of Division 01.

1.4 SUBMITTALS

A. Product Data:

1. Submit manufacturer's product data and installation instructions for all manufactured products and materials.

B. Record Documents:

1. Submit plans of all areas to receive tile Work showing the location of expansion and control joints, layout of tile units, and other conditions affecting the Work.

   a. Include details showing setting methods, expansion joint constructions, and relationships to adjacent substrates.

   b. Locate precisely each joint and crack in tile substrates by measuring, record measurements on shop Drawings, and coordinating them with tile joint locations, in consultation with Architect.

   1.01.1.1.4.1.1 Submit samples for initial selection purposes of each tile type and grout in form of manufacturer's color charts consisting of actual units or sections of units showing full range of colors, textures, and patterns available for each type of finish indicated.

   c. Where finish involves normal color and texture variations, include sample sets composed of two or more units showing full range of variations expected.

d. Include similar samples of material for joints and accessories involving color selection.

1.01.1.1.4.1.2 Submit samples for verification purposes of each type, class, and color/ pattern of tile required, not less than 18 inches square on plywood or hardboard backing, and grouted as required. Architect's review will be for color, pattern and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

e. Prepare and submit new samples, if requested, until appearance is acceptable to the Architect.

1.01.1.1.4.1.3 Provide manufacturer's Master Grade Certificate bearing TCA Certification mark and stating type, grade and location of material for all tile specified to be "Standard Grade".

2. Provide guarantee on waterproofing membrane stating that the waterproofing membrane will not leak, cause delamination of tile installation, or otherwise fail to perform as protective waterproofing for a period of five (5) years from the Date of Substantial Completion.

1.01.1.1.4.2 PERFORMANCE REQUIREMENTS

C. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level Surfaces: Minimum 0.6
2. Step Treads: Minimum 0.6
3. Ramp Surfaces: Minimum 0.8

D. Load-Bearing Performance: For ceramic tile installed on walkway surfaces, provide installations rated for the following load-bearing performance level based on testing assemblies according to ASTM C 627 that are representative of those indicated for this Project.

1. Extra Heavy: Passes cycles 1 through 14
2. Heavy: Passes cycles 1 through 12
3. Moderate: Passes cycles 1 through 10
4. Light: Passes cycles 1 through 6
5. Residential: Passes cycles 1 through 3

1.01.1.1.4.3 MOCK-UP INSTALLATION

E. Prior to beginning tile installation, arrange for a meeting, on-site, with the Architect to review proposed tile layout in each area scheduled to receive tile.

1. Arrange for a "mock-up" installation of tile at certain areas as directed to establish acceptable appearance standards.
2. In general, mock-up areas will be limited approximately 40 square feet each and will be located at intersections of floor and wall, at corners of rooms.

1.01.1.1.4.4 DELIVERY, STORAGE, AND HANDLING

F. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

1.01.1.1.5 Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

G. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If despite these precautions coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.5 PROJECT CONDITIONS

A. Maintain environmental conditions and protect Work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

1.01.1.1.6 Vent temporary heaters to exterior to prevent damage to tile Work from carbon dioxide buildup.

B. Maintain temperatures at 50 degrees F (10 degrees C) or more in tiled areas during installation and for seven (7) days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

1.6 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials that match products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.

1. Tile and Trim Units: Furnish quantity of full size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. The notes and schedules on the Drawings establish manufacturer and model/design of tile products required for the Project. Provide the products listed unless Architect approves products of other manufacturer specifically for this Project.

2.3 TILE SCHEDULE

A. Provide tile from the following manufacturer or as approved by architect:

1. Dal-Tile

2. Other approved equal

1.01.1.1.6.1 PRODUCTS, GENERAL

B. ANSI Standard for Ceramic Tile: Comply with ANSI A137.1 "American National Standard Specifications for Ceramic Tile" for types, compositions, and grades of tile indicated.

1. Furnish tile complying with "Standard Grade" requirements unless otherwise indicated.

C. ANSI Standard for Tile Installation Materials: Comply with ANSI standard referenced with products and materials indicated for setting and grouting.

1.01.1.1.7 Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

1. Match Architect's sample.

2. Match color, texture, and pattern indicated by reference to manufacturer's standard designations for these characteristics.

3. Provide selections made by Architect from manufacturer's full range of standard colors, textures, and patterns for products of type indicated.

4. Provide tile trim and accessories that match color and finish of adjoining flat tile.

D. Factory Blending: For tile exhibiting color variations within the ranges selected during sample submittals, blend tile in factory and package accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples.

1. Trim and Special Shapes: Rounded external corners, and trim shapes at head, jamb, and sills of opening, of same material and finish as tile, and as follows:

a. Base: At tiled walls, integral cove base; at vinyl fabric covered walls, integral cove, field tile and surface bullnose to form a base 5 inches high.

b. Base: At tiled floor and walls, integral cove base; at vinyl composition tile floors and tiled walls, straight field tile base; at vinyl composition tile floors and vinyl wallcovering, straight field tile and surface bullnose to form a base 4 inches high.

c. External Corners: Surface bullnose shapes.

d. Internal Corners: Field butted square, except use square corner-combination angle and stretcher type cap.

1.01.1.1.7.1.1 At locations indicated, provide tile manufacturer's abrasive grit surfaced tile for slip-resistant finish.

E. Mounting: Where factory mounted tile is required, provide back or edge mounted tile assemblies as standard with manufacturer unless another mounting method is indicated.

1. Where tile is indicated for installation in swimming pools, on exteriors or in wet areas, do not use back or edge mounted tile assemblies unless tile manufacturer specifies that this type of mounting is suitable for these kinds of uses and has been successfully used on other projects.

a. Internal Corners: Field butted square corners, except use coved base and cap angle pieces designed to member with stretcher shapes.

b. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide a reduction in thickness from 1/2 inch to 1/4 inch across nominal 4 INCH dimension.

F. For glazed wall tile, provide "Standard Grade" units, complying with ANSI A137.1. Provide 6" x 6" cushion edge units (except where square edge units are indicated), trim and special shapes as indicated and required.

1.01.1.1.8 Accessories for Glazed Wall Tile: Provide vitreous china accessories of type and size indicated and in color and finish to match adjoining glazed wall tile.

1. One soap holder for each shower and tub indicated.

2. One roll paper holder at each water closet.

1.01.1.1.8.1 QUARRY TILE

G. For quarry tile, provide "Standard Grade" units complying with ANSI A137.1. As indicted on drawings.

1. Color and Texture: As selected by Architect from standard quarry tile colors equivalent to American Olean Tile Company or Dal Tile Corp., as accepted by Architect.

2. At locations indicated, provide tile manufacturer's abrasive grit surfaced tile for slip-resistant finish.

3. Protect quarry tile against damage from furan grout by coating exposed faces with wax coating to produce a thin continuous film. Use wax which is compatible with grout and which is removable by a steaming method approved by tile and grout manufacturer. Apply wax in manner to avoid coating edges or backs and handle coated tile to prevent waxed surfaces from contacting backs or edges of other units.

1.01.1.1.8.2 (not used)

2.4 WATERPROOFING FOR THINSET TILE INSTALLATIONS

A. Polyethylene Sheet Waterproofing: Manufacturer's standard proprietary product consisting of composite sheets, 60 inches wide by a nominal thickness of 0.030, composed of an inner layer of chlorinated polyethylene sheet faced on both sides with laminated high strength nonwoven polyester material, designed for embedding in latex portland cement mortar, and as substrate for latex portland cement mortar setting bed.

1. "Nobleseal TS"; Noble Co. (distributed by H.B. Fuller Co.)

B. Liquid Applied Membrane: Cold applied rubberized elastomeric membrane incorporating a reinforcing fabric, nominally 20 mils thick, designed specifically for use as a waterproof membrane under tile installations.

1. "Laticrete 9235" by Laticrete International Inc., Bethany, Connecticut.

2. Provide manufacturer's recommended sealants and other accessories required for a complete installation.

1.01.1.1.8.3 MORTAR SETTING BED MATERIALS

C. Provide portland cement mortar as specified in the ANSI A 108 Series, Materials, and Installation Specifications with a Portland Cement mortar/sand mix in 1:6 proportion.

1.01.1.1.9 For "Thin Set/Dry Set" mortar bed setting, provide factory sanded Portland Cement mix with manufacturer's standard acrylic latex additive conforming to ANSI A 118.4.

1. American Olean "759 Thinset Mortar with AO Acrylic Thin Set Additive".

2. Laticrete "Floor 'N Wall Thin Set Mortar".

3. Mapei "Kerabond Premium".

4. C Cure Chemical Co. "Permabond with C Cure Latex Admixture".

1.01.1.1.9.1 ADHESIVE SETTING MATERIALS

D. For wall tile adhesive, provide factory mixed organic adhesive complying with ANSI A 136.1, Type I, with manufacturer's certification of conformance.

1. American Olean "AO 1700 Adhesive".

2. Laticrete "No. 15 Multi-Mastic".

3. Mapei "Ultra/Mastic 1".

4. C Cure Chemical Co. "Permabond 1002".

1.01.1.1.9.2 JOINT GROUT

E. For mosaic tile and glazed tile grout, provide manufactured joint grout conforming to ANSI A 118.6.

1. American Olean "Wall and Floor Grout".

2. Laticrete "Floor Grout" or "Wall Grout".

3. Mapei "Keracolor".

4. C Cure "MP Grout".

F. For epoxy grout, provide two-component epoxy grout conforming to ANSI 118.3.

1. American Olean "AO 6000 AAR II HT Epoxy Mortar and Grout".

2. Mapei "Kerapoxy".

3. C Cure "Epoxy 100".

G. For furan grout for quarry tile, provide furan grout conforming to ASTM C 658, 2 component polyfurfuryl alcohol based resin and hardeners; L & M Furan produced by L & M Surco Manufacturing Company, Inc.

2.5 MISCELLANEOUS MATERIALS

A. Metal Edge Strips: Zinc alloy or stainless steel terrazzo strips, 1/8 inch wide at top edge with integral provision for anchorage to mortar bed or substrate unless otherwise indicated.

1.01.1.1.10 Crack Isolation Membrane: Where thin-set tile will be installed over existing cracks in the substrate, provide an isolation membrane specifically manufactured for the purpose by one of the following:

1. "Laticrete 9235" by Laticrete International Inc.

2. "Crack Isolation Sheet CIS" by The Noble Company.

B. Temporary Protective Coating: Provide product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout, is compatible with tile and mortar/grout products, and is easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined, tasteless, odorless, containing at least 0.5 percent oil with a melting point of 120 degrees F (49 degrees C) to 140 degrees F (60 degrees C) per ASTM D 87.

2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as a temporary protective coating for tile.

1.01.1.1.10.1 MIXING MORTARS AND GROUT

C. Mix mortars and grouts to comply with requirements of referenced standards and manufacturers including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine substrates and areas where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, and free from oil or waxy films and curing compounds.

2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of Work, and similar items located in or behind tile has been completed before installing tile.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

1.01.1.1.11 Blending: For tile exhibiting color variations within the ranges selected during sample submittals, verify that tile has been blended in factory and packaged accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at the Project Site before installing.

C. Field Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent adhesion or staining of exposed tile surfaces by grout, protect exposed surfaces of tile against adherence of mortar and grout by precoating them with a continuous film of temporary protective coating indicated below, taking care not to coat unexposed tile surfaces:

1. Petroleum paraffin wax, applied hot.
2. Grout release.
3. Petroleum paraffin wax or grout release.

1.01.1.1.11.1 INSTALLATION

D. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.12 All installation shall be in accordance with manufacturer’s published recommendations.

E. ANSI Tile Installation Standard: Comply with parts of ANSI 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile" that apply to type of setting and grouting materials and methods indicated.

1. Dry Set or latex cement set wall and floor tile: ANSI A 108.5.
2. Organic adhesive set wall and floor tile: ANSI A 108.4.
3. Tile set in portland cement mortar bed: ANSI A 108.1.
4. Tile set in chemical resistant epoxy mortar and grout: ANSI A 108.6.
5. Tile set in chemical resistant furan mortar and grout: ANSI A 108.8.

F. TCA Installation Guidelines: TCA "Handbook for Ceramic Tile Installation"; comply with TCA installation methods indicated.

1.01.1.1.13 Extend tile Work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions except as otherwise shown. Terminate Work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

G. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile.

1.01.1.1.14 Carefully lay out tile in an endeavor to center the tiles to space them evenly, and to avoid cutting them. If cutting is necessary, cutting shall be done by saw cut or drilling only, no tile cutters or snipped edges allowed; all cut ends shall be rubbed smooth and even. Lay out tile so that no tile less than 1/2 size occurs. For height stated in feet and inches, maintain full courses to produce nearest attainable heights without cutting tile. Align joints in wall tile vertically and horizontally. No staggering of joints will be permitted. All cutting and drilling shall be done without marring surfaces and shall be done neatly to fit closely around pipes, fixtures, and fittings so that cover plates will overlap cuts.

H. Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile Work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths unless otherwise shown.

1. Confirm locations of joints in substrate will align with planned expansion joints in tile Work. Adjust layout of tile if necessary to align expansion joints with substrate conditions.

2. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so that extent of each sheet is not apparent in finished Work.

I. Lay out tile wainscots to next full tile beyond dimensions indicated.

1.01.1.1.15 Expansion Joints: Locate expansion joints and other sealant filled joints, including control, Contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw cut joints after installation of tiles.

1. Locate joints in tile surfaces directly above joints in concrete substrates.

2. Prepare joints and apply sealants to comply with requirements of Division 07 Section "Joint Sealers."

J. Grout tile to comply with the requirements of the following installation standards:

1. For ceramic tile grouts (sand portland cement, dry set, commercial portland cement, and latex portland cement grouts), comply with ANSI A108.10.

2. For chemical resistant epoxy grouts, comply with ANSI A108.6.

3. For chemical resistant furan grouts, comply with ANSI A108.8.

1.01.1.1.15.1 WATERPROOFING FOR THINSET TILE INSTALLATIONS

K. Install waterproofing in compliance with waterproofing manufacturer's instructions to produce a waterproof membrane of uniform thickness bonded securely to substrate.

1.01.1.1.16 Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.2 FLOOR INSTALLATION METHODS

A. Thick Set Setting Bed:

1. Mortar Bed: 1-1/4 inch to 2 inch thick latex-portland cement mortar.

2. Bond Coat: Portland cement paste on plastic mortar bed or latex-portland cement mortar on cured mortar bed (Contractor's option).

3. On Grade: TCA F112.

4. Above Grade: TCA F111.

5. Over Waterproof Membrane: TCA F121.

6. With Epoxy Mortar and Bond Coat: TCA F132.

B. Medium Set Setting Bed; Tiles 8" x 8" and Larger:

1. Bond Coat: 3/8 inch to ¾ inch thick medium bed dry set latex-portland cement mortar.

2. Typical: TCA F113, except for bond coat thickness.

3. Over Waterproof Membrane: TCA F122, except for bond coat thickness.

C. Thin Set Setting Bed; Tiles 6" x 6" and Smaller:

1. Bond Coat: 3/32 inch minimum thick dry set latex-portland cement mortar.

2. Typical: TCA F113.

3. Over Waterproof Membrane: TCA F122.

4. With Epoxy Mortar and Grout: TCA F131.

D. Set marble thresholds in thin set mortar setting beds; point threshold base flush with adjoining tile floors. Comply with TCA Method TH821.

3.3 WALL TILE INSTALLATION METHODS

A. Install types of tile designated for wall application to comply with requirements indicated below for setting bed methods, TCA installation methods related to subsurface wall conditions, and grout types:

1.01.1.1.17 Over gypsum board, use organic adhesive in accordance with TCA Method W242.
B. Over glass mesh mortar units, at typical locations, use latex portland cement mortar in accordance with TCA Method W244.

1. At Bath Tubs; TCA B412.

2. At Showers; TCA B415.

C. Over masonry or concrete use latex portland cement mortar; TCA W202.

3.4 GROUT

A. Wall Joints (less than 1/8 inches wide): Unsanded Grout.

1.01.1.1.18 Floor and Wall Joints (1/8 inch to 5/8 inch wide): Sanded Grout.
B. Floor Joints in Showers, and all Quarry Tile Joints (1/16 inch to 3/8 inch wide): Epoxy Grout.

3.5 EXPANSION JOINT INSTALLATION

A. At all floor tile installations, provide expansion joints at perimeter of area to be tiled, at all penetrations in tile Work, and 12 feet 0 inches on center both ways as recommended in the TCA "Handbook for Ceramic Tile Installation" unless closer spacing is indicated or required by Project conditions. Install removable strips of the same depth as the finished tile system including setting bed. Remove strips after grouting and curing operations.

1. Install joints in accordance with TCA Method EJ711.

1.01.1.1.18.1 CLEANING AND PROTECTION
B. Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove latex portland cement grout residue from tile as soon as possible.

2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than fourteen (14) calendar days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.

3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to brick and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

C. Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile Work.

1.01.1.1.19 Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensures tile is without damage or deterioration at time of Substantial Completion.

1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile Work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.

2. Prohibit foot and wheel traffic from tiled floors for at least seven (7) calendar days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION 09 31 00 00

SECTION 09 51 13 00 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has successfully completed acoustical ceilings similar in material, design, and extent to those indicated for Project.

1.01.1.1.3 Fire Performance Characteristics: Provide acoustical ceilings that are identical to those tested for the following fire performance characteristics, per ASTM test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.

1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 for Class A products.

   a. Flame Spread: 25 or less.

   b. Smoke Developed: 50 or less.

   1.01.1.1.3.1.1 Fire Resistance Ratings: As indicated by reference to design designations in UL "Fire Resistance Directory," for types of assemblies in which acoustical ceilings function as a fire protective membrane and tested per ASTM E 119.

   c. Protect lighting fixtures and air ducts to comply with requirements indicated for rated assembly.

B. Single Source Responsibility for Ceiling Units: Obtain each type of acoustical ceiling unit from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.01.1.1.4 Single Source Responsibility for Suspension System: Obtain each type of suspension system from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

C. Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire suppression system components (if any), and partition system (if any).

1.01.1.1.5 Preinstallation Conference: Conduct conference at Project Site.

1.4 SUBMITTALS

A. Coordination Drawings:

1. Reflected ceiling plans drawn accurately to scale and coordinating penetrations and ceiling mounted items. Show the following:
    a. Ceiling suspension members.
    b. Method of attaching hangers to building structure.
    c. Ceiling mounted items including light fixtures; air outlets and inlets; speakers; sprinkler heads; and special moldings at walls, column penetrations, and other junctures with adjoining construction.

B. Samples:

1. Samples for verification purposes of each type of exposed finish required, prepared on samples of size indicated below and of same thickness and material indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.
    a. 6” X 6” samples of each unit pattern and color required.
    b. Set of 12 inch long samples of exposed suspension system members, including moldings, for each color and system type required.

1.5 DELIVERY, STORAGE and HANDLING

A. Deliver acoustical ceiling units to Project Site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

1.01.1.1.6 Before installing acoustical ceiling units, permit them to reach room temperature and stabilized moisture content.

B. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

1.6 PROJECT CONDITIONS

A. Space Enclosure: Do not install interior acoustical ceilings until space is enclosed and weatherproof, wet Work in space is completed and nominally dry, Work above ceilings is complete, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 METAL SUSPENSION SYSTEMS, GENERAL

A. Standard for Metal Suspension Systems: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.

1.01.1.1.7 Finishes and Colors: Provide manufacturer's standard factory applied finish for type of system indicated.

1. High Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high humidity finishes are indicated.

B. Attachment Devices: Size for 5 times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

1. Cast In Place and Post-installed Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion resistant materials, with holes or loops for attachment of hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing per ASTM E 488, conducted by a qualified independent testing laboratory.

a. Cast in place anchors.

b. Chemical anchors.

c. Expansion anchors.

d. Undercut anchors.

1.01.1.1.7.1.1 Powder Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion resistant materials, with clips or other accessory devices for attachment of hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing laboratory.

C. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.

1. Gage: Provide wire sized so that stress at 3 times hanger design load (ASTM C 635, Table 1, Direct Hung), will be less than yield stress of wire, but provide not less than 0.106 inch diameter (12 gage).

D. Hanger Rods: Mild steel, zinc coated, or protected with rust inhibitive paint.

1.01.1.1.8 Flat Hangers: Mild steel, zinc coated, or protected with rust inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8 inch wide, formed with 0.0365 inch thick galvanized steel sheet complying with ASTM A 446, Coating Designation G90, with bolted connections and 5/16 inch diameter bolts.

1.01.1.1.9 Edge Moldings and Trim: Metal or extruded aluminum of types and profiles indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit type of edge detail and suspension system indicated. Provide trim with hemmed edges.

1. For lay in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.

2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

3. For narrow faced suspension systems, provide suspension system manufacturer's standard edge moldings that match width and configuration of exposed runners.

1.01.1.1.9.1 EXPOSED GRID SYSTEM

F. Provide double web main and cross runners, 1-1/2 inch deep nominally, with painted aluminum cap.

1.01.1.1.10 For direct hung system, provide "intermediate duty" structural classification per ASTM C 635.

G. Exposed grid system for Shall be one of the following unless noted on drawings:

CEILING ANGLE WHITE 7/8" X 7/8" X 12'
DONN # M7
TEE CEILING GRID CROSS 48" X 1-1/2"
DONN #DX-422

TEE CROSS DONN DX 524 56" X 1-1/2"

TEE MAIN CEILING GRID 6" CENTERS X 12'
DONN DX-24

2.3 ACOUSTIC UNIT MATERIALS

A. Provide units of configuration indicated which are prepared for mounting method designated and which comply with ASTM E 1264 requirements, including those indicated by reference to type, form, pattern, grade (NRC as applicable), light reflectance coefficient (LR), edge detail, and joint detail (if any).

1.01.1.1.11 Acoustic units are specified below by manufacturer and design to establish standards of appearance and performance. Equivalent products of other manufacturers may be incorporated into the Work if accepted by the Architect.

B. Provide the following lay-in acoustic panels where indicated. Units shall be one of the following, unless noted otherwise on drawings:

CEILING TILE 24" X 24" X 5/8" ARMSTRONG 756A
CEILING TILE 24″ X 48″ X 5/8″ ARMSTRONG 1900
CEILING TILE 24" X 24" X 3/4" ECLIPSE USG 76775
CEILING TILE 24" X 48" X 1/2" USG 3270 - gypsum panel
CEILING TILE 24" X 48" X 5/8" BASIC USG 562
CEILING TILE 24" X 48" X 5/8" ARMSTRONG 1773
CEILING TILE 24" X 60" X 5/8" ARMSTRONG 772
CEILING TILE 24" X 48" X 5/8" ARMSTRONG 755B
CEILING TILE 24" X 48" X 5/8" ARMSTRONG 763D - USDA approved
CEILING TILE 24" X 48" X 5/8" ARMSTRONG 895
CEILING TILE 24″ X 24″ X 3/4" MILLENNIA USG 76705
CEILING TILE 24″ X 24″ X 5/8″ CLEAN ROOM USG 56099 washable vinyl
CEILING TILE 24" X 48" X 5/8" ARMSTRONG 769A
CEILING TILE 48" X 40" X 1" OWENS CORNING 26T40100
CEILING TILE 24" X 48" X 3/4" USG RADAR ILLUSION 2882 - tapered
CEILING TILE 24" X 48" X 5/8" ARMSTRONG 2906 - washable vinyl
CEILING TILE 24" X 24" X 3/4" ARMSTRONG 589 - beveled

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling system. Do not proceed with installation until unsatisfactory conditions have been corrected.

1.01.1.1.12 Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.

1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other Work.

B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.13 All installation shall be in accordance with manufacturer’s published recommendations.

B. Install acoustical ceiling systems to comply with installation standard referenced below, per manufacturer's instructions and CISCA "Ceiling Systems Handbook."

1. Standard for Installation of Ceiling Suspension Systems: Comply with ASTM C 636.

2. Standards for Installation of Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM C 636 and ASTM E 580.

3. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."

4. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4.

5. U.B.C.'s "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings": U.B.C. Standard 25-2.

C. Arrange acoustical units and orient directionally patterned units (if any) in manner shown by reflected ceiling plans.

1. Install units with pattern running in one direction.

2. Install units with pattern running in alternating directions to form checkerboard layout.

D. Suspend ceiling hangers from building structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

3. Secure wire hangers by looping and wire tying, either directly to structures or to inserts, eyescrews, or other devices that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

4. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices that are secure and appropriate for structure to which hangers are attached as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

5. Do not support ceilings directly from permanent metal forms; furnish cast in place hanger inserts that extend through forms.

6. Do not attach hangers to steel deck tabs.

7. Do not attach hangers to steel roof deck. Attach hangers to structural members.

8. Space hangers not more than 4' 0" on center along each member supported directly from hangers, unless otherwise shown, and provide hangers not more than 8 inches from ends of each member.

E. Install edge moldings of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical units.

   1. Screw attach moldings to substrate at intervals not over 16 inches on center and not more than 3 inches from ends, leveling with ceiling suspension system to tolerance of 1/8 inch in 12' 0". Miter corners accurately and connect securely.

   2. When using pop rivets use white color.

F. Install suspension system runners so they are squared and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

1.01.1.1.14 Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

G. Install acoustical units in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.

   1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.

   2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.

   3. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.

   4. Paint cut panel edges remaining exposed after installation; match color of exposed panel surfacing using coating recommended in writing for this purpose by acoustical panel manufacturer.

   5. Install hold down clips in areas indicated and in areas where required by governing regulations or for fire resistance ratings; space as recommended by panel manufacturer, unless otherwise indicated or required.

END OF SECTION 09 51 13 00

SECTION 09 63 43 00 - RESINOUS FLOORING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for resinous flooring. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Decorative resinous flooring systems.
      b. Industrial resinous flooring systems.
      c. High-performance resinous flooring systems.

C. Submittals
   1. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
   2. LEED Submittal:
      a. Product Data for Credit EQ 4.2: For resinous flooring systems, documentation including printed statement of VOC content and chemical components.
   3. Samples: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.
   4. Product Schedule: For resinous flooring. Use same designations indicated on Drawings.
   5. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
   6. Material Certificates: For each resinous flooring component, from manufacturer.
   7. Material Test Reports: For each resinous flooring system.
   8. Maintenance Data: For resinous flooring to include in maintenance manuals.

D. Quality Assurance
   1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.
      a. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
   2. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
   3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
   1. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

F. Project Conditions
   1. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
   2. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
   3. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

1.2 PRODUCTS

A. Approved Manufacturers:
  1. Sika Flooring
  2. HP Spartcote
  3. StoneHard
  4. Or Approved Equal

B. Materials
  1. VOC Content of Resinous Flooring: Provide resinous flooring systems, for use inside the weatherproofing system, that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    a. Resinous Flooring: 100 g/L.

C. Decorative Resinous Flooring
  1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, decorative-aggregate-filled, epoxy-resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
  2. System Characteristics:
    a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
    b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
    c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
    d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
  3. Body Coats:
    a. Resin: Epoxy.
    b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
    c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
      1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
      2) Number of Coats: One **OR** Two, **as directed**.
    d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
  4. Topcoat: Sealing or finish coats.
    a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
    b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
    c. Type: Clear **OR** Pigmented, **as directed**.
    d. Finish: Matte **OR** Gloss, **as directed**.
    e. Number of Coats: One **OR** Two, **as directed**.
  5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
    a. Compressive Strength: per ASTM C 579.
    b. Tensile Strength: per ASTM C 307.
    c. Flexural Modulus of Elasticity: per ASTM C 580.
    d. Water Absorption: per ASTM C 413.
    e. Coefficient of Thermal Expansion: per ASTM C 531.
    f. Indentation: per MIL-D-3134.
    g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
    h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.

- i. Abrasion Resistance: maximum weight loss per ASTM D 4060.
- j. Flammability: Self-extinguishing per ASTM D 635.
- k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.
- l. Hardness: Shore D per ASTM D 2240.
- m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days:

D. Industrial Resinous Flooring

1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, industrial-aggregate-filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
2. System Characteristics:
   - a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
   - b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
   - c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
   - d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
3. Body Coats:
   - a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
   - b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
   - c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
     - 1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
     - 2) Number of Coats: One **OR** Two, **as directed**.
   - d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
4. Topcoat: Sealing or finish coats.
   - a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
   - b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
   - c. Type: Clear **OR** Pigmented, **as directed**.
   - d. Finish: Matte **OR** Gloss, **as directed**.
   - e. Number of Coats: One **OR** Two, **as directed**.
5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
   - a. Compressive Strength: per ASTM C 579.
   - b. Tensile Strength: per ASTM C 307.
   - c. Flexural Modulus of Elasticity: per ASTM C 580.
   - d. Water Absorption: per ASTM C 413.
   - e. Coefficient of Thermal Expansion: per ASTM C 531.
   - f. Indentation: percent maximum per MIL-D-3134.
   - g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
   - h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.
   - i. Abrasion Resistance: maximum weight loss per ASTM D 4060.
   - j. Flammability: Self-extinguishing per ASTM D 635.
   - k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.

l. Hardness: Shore D per ASTM D 2240.
m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days:

E. High-Performance Resinous Flooring

1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance-aggregate-filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
2. System Characteristics:
   a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
   b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
   c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
   d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
3. Body Coats:
   a. Resin: Epoxy **OR** Epoxy novolac **OR** Urethane **OR** Vinyl ester **OR** Methyl methacrylate, **as directed**.
   b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
   c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
      1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
      2) Number of Coats: One **OR** Two, **as directed**.
   d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
4. Topcoat: Sealing or finish coats.
   a. Resin: Epoxy **OR** Epoxy novolac **OR** Urethane **OR** Vinyl ester **OR** Methyl methacrylate, **as directed**.
   b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
   c. Type: Clear **OR** Pigmented, **as directed**.
   d. Finish: Matte **OR** Gloss, **as directed**.
   e. Number of Coats: One **OR** Two, **as directed**.
5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
   a. Compressive Strength: per ASTM C 579.
   b. Tensile Strength: per ASTM C 307.
   c. Flexural Modulus of Elasticity: per ASTM C 580.
   d. Water Absorption: per ASTM C 413.
   e. Coefficient of Thermal Expansion: per ASTM C 531.
   f. Indentation: percent maximum per MIL-D-3134.
   g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
   h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.
   i. Abrasion Resistance maximum weight loss per ASTM D 4060.
   j. Flammability: Self-extinguishing per ASTM D 635.
   k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.
   l. Hardness: Shore D per ASTM D 2240.
   m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days:

F. Accessories
1. Primer: Type recommended by manufacturer for substrate and body coats indicated.
    a. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
2. Waterproofing Membrane: Type recommended by manufacturer for substrate and primer and body coats indicated.
    a. Formulation Description: 100 percent solids **OR** High solids, **as directed**.
3. Reinforcing Membrane: Flexible resin formulation that is recommended by manufacturer for substrate and primer and body coats indicated and that prevents substrate cracks from reflecting through resinous flooring.
    a. Formulation Description: 100 percent solids **OR** High solids, **as directed**.
        1) Provide fiberglass scrim embedded in reinforcing membrane.
4. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

1.3 EXECUTION

A. Preparation
1. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.
2. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
    a. Roughen concrete substrates as follows:
        1) Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
        OR
        Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.
    b. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
    c. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
        1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) of slab area in 24 hours.
        2) Perform plastic sheet test, ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
        3) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
    d. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
3. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
4. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
5. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

B. Application
  1. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
    a. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
    b. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
    c. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
  2. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
  3. Apply waterproofing membrane, where indicated, in manufacturer's recommended thickness.
    a. Apply waterproofing membrane to integral cove base substrates.
  4. Apply reinforcing membrane to substrate cracks **OR** entire substrate surface, **as directed**.
  5. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
    a. Integral Cove Base: 4 inches (100 mm) high.
  6. Apply self-leveling slurry body coats in thickness indicated for flooring system.
    a. Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.
  7. Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.
  8. Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat and to produce wearing surface indicated.
  9. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

C. Field Quality Control
  1. Core Sampling: At the direction of Owner and at locations designated by Owner, take one core sample per 1000 sq. ft. (92.9 sq. m) of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring and correct deficiencies.
  2. Material Sampling: Owner may at any time and any number of times during resinous flooring application require material samples for testing for compliance with requirements.
    a. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
    b. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
    c. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

D. Protection
  1. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 63 43 0062 00 00

SECTION 09 65 13 00 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Single Source Responsibility for Products: Obtain each type and color of product specified from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.01.1.1.3 Special Requirements of Regulatory Agencies: Submit certification that system complies with VOC (Volatile Organic Compounds) requirements and regulations of the Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), State, County, City, and local Air Control District.

B. Mockups: Provide resilient products with mockups specified in other sections.

1.01.1.1.4 Fire Test Response Characteristics: As determined by testin identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classifications: Class 1, > 0.45 w/sg.cm.

1.01.1.1.4.1 SUBMITTALS

C. Samples:

1. Samples for initial selection purposes of manufacturer's standard sample sets in form of pieces cut from each type of product specified showing full range of colors and patterns available.

2. Samples for verification purposes in manufacturer's standard sizes, but not less than 12 inches long, of each different color and pattern of product specified.

1.01.1.1.4.2 DELIVERY, STORAGE and HANDLING

D. Deliver products to Project Site in original manufacturer's unopened cartons and containers, each bearing names of product and manufacturer, Project identification, and shipping and handling instructions.

1.01.1.1.5 Store products in dry spaces protected from the weather with ambient temperatures maintained within the range recommended by manufacturer but not less than 50 degrees F (10 degrees C) or more than 90 degrees F (32 degrees C).

E. Unboxed wall base, corners, and adhesive area to be moved into the installation space at least 48 hours before installation and are to be maintained between 65 degrees F and 85 degrees F.

1.4 PROJECT CONDITIONS

A. Maintain a temperature between 65 degrees F and 85 degrees F in spaces to receive products specified in this Section for at least 48 hours prior to installation, during installation, and thereafter.

1.01.1.1.6 A bond test should be performed at least 72 hours prior to the schedule installation to ensure the surface is suitable.

B. Close spaces to traffic during installation of products specified in this Section.

1.5 SEQUENCING AND SCHEDULING

A. Sequence installing products specified in this Section with other construction to minimize possibility of damage and soiling during remainder of construction period.

1.6 warranty

A. Wall base products will be warranted for a period of one (1) year from the date of installation with three (3) limited wear warranty

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.7 The notes and schedules on the Drawings establish manufacturer and model/design required for the Project. Provide the products listed below unless Architect approves products of other manufacturer specifically for this Project.

2.2 manufacturers

A. To establish standards of manufacture, operation, performance, and appearance, drawings and specifications are based on the specific manufacturer's products and color/patterns shown on the Drawings. If accepted in advance by the Architect, and provided compliance with requirements, products of the following manufacturers may also be acceptable:

1. Roppe , Johnsonite, Burke

a. Pinnacle Rubber Base

1) Flooring accessories shown in the finish schedule or listed herein as Cove Base or Wall Base shall be 1/8" (3.175mm) thick Type TS, Thermoset Vulcanized Pinnacle EXTRUDED RUBBER WALL BASE as manufactured by Roppe Corporation, Fostoria, Ohio. It shall be constructed of first quality materials, properly vulcanized, and shall be smooth and free from imperfections which detract from Its appearance. The base shall conform fully to all the requirements of Standard Specification F-1861, Type TS (Thermoset Vulcanized Rubber), Group 1 (solid). All Wall Base shall be of the type (Straight, Style A, or Cove, Style B), with a nominal height of 4" {101.6mm}, in nominal lengths of (48" {1.22m}, in the color stated, and 1/8" (3.175mm) nominal thickness, unless noted otherwise.

2) Sanitary Wall Base shall be 4" (101.6mm) high with a 2" (50.8mm) Sanitary Toe. The toe shall be 1/8" (3.175mm) nominal thick. The length shall be (48" {1.22m}) nominal long and in the color selected

1.01.1.1.7.1.1.1 Pinnacle Plus Rubber Base

3) Flooring accessories shown in the finish schedule or listed herein as Cove Base or Wall Base shall be 1/8" (3.175mm) thick Type TS, Thermoset Vulcanized Pinnacle Plus EXTRUDED RUBBER WALL BASE as manufactured by Roppe Corporation, Fostoria, Ohio. It shall be constructed of first quality materials, properly vulcanized, and shall be smooth and free from imperfections which detract from Its appearance. The base shall conform fully to all the requirements of Standard Specification F-1861, Type TS (Thermoset Vulcanized Rubber), Group 1 (solid). All Wall Base shall be of the style(style B, Base Shoe or Cove), with a height of 4" (101.6mm) nominal, in the color stated , and 1/8" (3.175mm) nominal thickness.

2.3 RESILIENT WALL BASE

A. Provide the following resilient base materials at locations indicated on plans.

1.01.1.1.8 Lengths: **4 foot lengths, NO COILS**

B. Exterior Corners: Factory molded outside corners required.

1.01.1.1.9 Interior Corners: Premolded or formed on job

2.4 ACCESSORIES

A. Provide reducer strips, transition strips, and other accessories required in the Work from the same manufacturer as the resilient wall base. The following accessories are products of Roppe Corporation and are listed to establish configuration, size, and shape of items only.

1. Where scheduled in colors matching base, provide accessories from the same color run to assure acceptable match.

B. Accessories:

1. Carpet to O Reducer Strip: Type 160
2. Reducer: Type 172
3. Transition Strip; Carpet Reducer 159
4. Transition Strip; Ceramic to Wood: Type 182

C. Provide accessories in proper thickness to accommodate adjacent flooring materials.

2.5 RESILIENT STAIR ACCESSORIES

A. Products of style suitable for use indicated, provided by same manufacturer as resilient base. Color and pattern to by selected by Architect from manufacturer’s full range of colors and patterns produced from rubber stair accessories, including:

1. Stair Treads: [Type 1 design (smooth)] [Type 2 design (designed)] [Type 4 design (grooved lead antimony or aluminum/oxide silicone carbide filled channels)] products complying with the following requirements.
2. Risers: [Smooth flat risers with cove toe, 1/8 inch thick by 7 inches high by length to match that of treads.] [Smooth flat risers without cove toe, 1/8 inch thick by height and length to cover risers.] Stringers: Material matching risers, of height and length after cutting to fit risers and treads to cover stair stringers.

1.01.1.1.9.1 INSTALLATION ACCESSORIES

B. Concrete Slab Primer: Nonstaining type as recommended by flooring manufacturer.

1.01.1.1.10 Trowelable Underlayments and Patching Compounds: Latex modified, portland cement based formulation provided or approved by flooring manufacturer for applications indicated.

C. Stair Tread Nose Filler: Two part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates not conforming to tread contours.

1.01.1.1.11 Adhesives: Water resistant type recommended by manufacturer to suit resilient flooring product and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas where installation of products specified in this Section will occur, with Installer present, to verify that substrates and conditions are satisfactory for installation and comply with manufacturer's requirements and those specified in this Section.

1.01.1.1.12 Comply with manufacturer's installation specifications for preparing substrates indicated to receive products indicated.

B. Use trowelable leveling and patching compounds per manufacturer’s directions to fill cracks, holes, and depressions in substrates.

1.01.1.1.13 Use stair tread nose filler per tread manufacturer's directions to fill nosing substrates not conforming to tread contours.

C. Remove coatings, including curing compounds, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy duty wire brush.

1.01.1.1.14 Broom or vacuum clean substrates to be covered immediately before installing products specified in this Section. Following cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.

D. Apply concrete slab primer, if recommended by flooring manufacturer, prior to applying adhesive. Apply according to manufacturer's directions.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.15 All installation shall be in accordance with manufacturer’s published recommendations.

B. Install products specified in this Section using methods indicated according to manufacturer's installation directions.

1.01.1.1.16 Apply resilient wall base to walls, columns, pilasters, casework, and other permanent fixtures in rooms and areas where base is required. Install wall base in lengths as long as practicable. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

1. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.

2. Install inside and exterior corners before installing straight pieces.

3. Form inside corners on job from straight pieces of maximum lengths possible by cutting an inverted V shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce snug fit to substrate.

4. Install Roppe (or approved equal). Factory Molded Outside Rubber Corners on all Projects awarded on or after April 1, 2013, at all outside corners of wall base whenever the wall exceeds the length of the returns on the base.

C. Place resilient accessories so they are butted to adjacent materials of type indicated and bond to substrates with adhesive. Install reducer strips at edges of flooring that otherwise would be exposed.

1.01.1.1.17 Apply resilient accessories to stairs as indicated and according to manufacturer's installation instructions.

3.3 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing installation:

1. Remove visible adhesive and other surface blemishes using cleaner recommended by manufacturers of resilient product involved.

2. Apply protective floor polish to resilient accessories that are free from soil, visible adhesive, and surface blemishes.

   a. Use commercially available cross linked, acrylic product acceptable to resilient accessory manufacturer.

   b. Coordinate selection of floor polish with Owner's maintenance service.

B. Protect flooring against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended by manufacturer of resilient product involved.

1.01.1.1.18 Clean products specified in this Section not more than four (4) days prior to dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Clean products using method recommended by manufacturer.

1. Strip protective floor polish that was applied after completing installation, prior to cleaning.

2. Reapply floor polish after cleaning.

END OF SECTION 09 65 13 00

SECTION 09 65 16 00 - RESILIENT SHEET FLOORING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Toli Sheet vinyl floor coverings.

B. Related Documents: Specifications throughout Divisions of the Project Manual are directly applicable to this section and this section is directly applicable to them.

1.02 REFERENCES

A. ASTM International:

1. ASTM E648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
2. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
3. ASTM F710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
4. ASTM F970 Standard Test Method for Static Load Limit.
5. ASTM F1303 Standard Specification for Sheet Vinyl Floor Covering with Backing.
6. ASTM F1914 Standard Test Method for Short-Term Indentation and Residual Indentation of Resilient Floor Covering.

B. National Fire Protection Association (NFPA):

1. NFPA 253 Standard Method of Test for Critical Radiant Flux for Floor Covering Systems Using a Radiant Energy Source.
2. NFPA 258 Research Test Method for Determining Smoke Generation of Solid Materials.

1.04 SUBMITTALS

A. General: Submit listed submittals in accordance with General Conditions of the Contract and Division 1 Submittal Procedures Section.

B. Product Data: Submit product data, including manufacturer’s SPEC-DATA® sheet, for specified products.

C. Samples: Submit selection and verification samples of finishes, colors and textures (24” X 23” square sample)

D. Shop drawings indicating resilient sheet flooring type, layout, pattern direction, edge transitions, columns, doorways, partitions, build-in furniture, cabinets, cutouts, expansion and control joints, and attachment requirements.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements and Approvals, as directed.

1.06 DELIVERY, STORAGE & HANDLING

A. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1.06 WARRANTY

A. Floor products will be warranted to be free from defects in material and workmanship for ten (10) years from date of invoice to original end users

PART 2 PRODUCTS

2.01 SHEET VINYL FLOOR COVERING

A. Manufacturer: TOLI International, a Division of CBC (America) Corp., 55 Mall Drive, Commack, NY 11725; Telephone: (800) 446-5476; Technical Support: (888) TRY-TOLI; Fax: (631) 864-8151; E-mail: support@toli.com; website: www.toli.com.or approved equal.

2.02 MATERIALS

A. Mature Collection, or as noted on drawings

1. Classification: ASTM F1303, Type I, Grade 1, embossed, clear, semi-rigid PVC commercial grade wearlayer over photographic print film design.
2. Size: 6 foot × 66 foot (1.8 × 20 m) rolls.
3. Gauge: 0.080 inch (2.03 mm).
4. Backing: ASTM F1303, Class B, 3-ply fused backing system consisting of fiberglass inner layer, PVC backing layer, with 45% recycled material, and polyester scrim backing.
5. Recovery from Long-Term Indentation (ASTM F970): 2500 psi (17,225 kPa).
6. Pass when tested in accordance with ASTM F1914.
7. Pattern and Color: As selected by the Architect from the manufacturer’s standard patterns and colors in the Mature Woods and Mature Opus and lines.

B. Adhesive: CBC 5000 Premium Resilient Flooring Adhesive or CBC 950, as recommended by the manufacturer.

C. Installation Accessories

1. Concrete Slab Leveling and Patching Compound: Non-staining type as recommended by flooring manufacturer.
2. Adhesives (Acrylic): Solvent-free, ion odor, acrylic based, high tack type adhesive as recommended by manufacturer to suit sheet vinyl floor covering products and substrate conditions indicated. Or adhesives- heavy duty Epoxy: 2-part solvent-free, low odor, flooring epoxy adhesive as recommended by manufacturer.
3. Seam Seal: Formulation provided or approved by floor covering manufacturer for products indicated
   a. Heat Welding- color to be selected by Architect
   b. Cold Welding

4. Floor Finish System: Provide protective liquid floor polish product systems as recommended by flooring manufactuer.

PART 3 EXECUTION

3.01 MANUFACTURER’S INSTRUCTIONS

A. Compliance: Comply with manufacturer’s product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.

3.02 EXAMINATION

A. Site Verification of Conditions: Verify that substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions. Slab substrates to be dry and free of curing compounds, sealers, hardeners, and other material whose presence would interfere with the hardening of adhesives. Determine adhesion and dryness characteristics by performing bond and moisture test as recommended by manufacturer

3.03 PREPARATION

A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.04 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install products specified in this Section using methods indicated according to manufacturer's installation directions.

D. Apply resilient wall base to walls, columns, pilasters, casework, and other permanent fixtures in rooms and areas where base is required. Install wall base in lengths as long as practicable. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.

F. Install inside and exterior corners before installing straight pieces.

G. Form inside corners on job from straight pieces of maximum lengths possible by cutting an inverted V shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce snug fit to substrate.

H. Form outside corners on job from straight pieces of maximum lengths possible by shaving back of base at point where bending will occur. Remove a strip perpendicular to length of base and only deep enough to produce a snug fit without bends whitening or removal of more than half the thickness of wall base.

I. Place resilient accessories so they are butted to adjacent materials of type indicated and bond to substrates with adhesive. Install reducer strips at edges of flooring that otherwise would be exposed.

J. Apply resilient accessories to stairs as indicated and according to manufacturer's installation instructions.

3.05 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing installation:

C. Remove visible adhesive and other surface blemishes using cleaner recommended by manufacturers of resilient product involved.

1. Sweep or vacuum floor thoroughly.
2. Do not wash floor until after time period recommended by manufacturer.
3. Damp mop resilient accessories to remove black marks and soil.
4. Apply protective floor polish to resilient accessories that are free from soil, visible adhesive, and surface blemishes.

D. Use commercially available cross linked, acrylic product acceptable to resilient accessory manufacturer.

   a. Coordinate selection of floor polish with Owner's maintenance service.

B. Protect flooring against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended by manufacturer of resilient product involved.

C. Clean products specified in this Section not more than four (4) days prior to dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Clean products using method recommended by manufacturer.

END OF SECTION 09 65 16 0065 13 33a

SECTION 09 65 19 00 - RESILIENT TILE FLOORING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Armstrong and Tarkett resilient vinyl tile modular flooring.

B. Related Sections:

   1. Specifications throughout all Divisions of the Project Manual are directly applicable to this section and this section is directly applicable to them.

1.02 REFERENCES

A. ASTM International (ASTM):

   1. ASTM E 648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
   2. ASTM E 662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
   3. ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
   4. ASTM F 1066 Standard Specification for Vinyl Composition Tile
   5. ASTM F 1482, Standard Guide to Wood Underlayment Products Available for Use Under Resilient Flooring
   6. ASTM F 1861 Standard Specification for Resilient Wall Base
   7. ASTM F 1869 Standard Test Method for Measuring Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
   8. ASTM F 2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

B. National Fire Protection Association (NFPA):

   1. NFPA 253 Standard Method of Test for Critical Radiant Flux for Floor Covering Systems Using a Radiant Heat Energy Source.
   2. NFPA 258 Research Test Method for Determining Smoke Generation of Solid Materials.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data for specified products.

B. C. Samples: Submit selection and verification samples of finishes, colors, and textures.

1.04 QUALITY ASSURANCE

A. Single-Source Responsibility: provide types of flooring and accessories supplied by one manufacturer, including moisture mitigation systems, primers, leveling and patching compounds, and adhesives.

B. Select an installer who is experienced and competent in the installation of Armstrong resilient vinyl composition tile flooring and the use of Armstrong Flooring subfloor preparation products.

   1. Engage installers certified as Armstrong Commercial Flooring Certified Installers
   2. Confirm installer's certification by requesting their credentials

C. Fire Performance Characteristics: Provide resilient vinyl composition tile flooring with the following fire performance characteristics as determined by testing material in accordance with ASTM test methods indicated below by a certified testing laboratory or other testing agency acceptable to authorities having jurisdiction:

1. ASTM E 648 Critical Radiant Flux of 0.45 watts per sq. cm. or greater, Class I
2. ASTM E 662 (Smoke Generation) Maximum Specific Optical Density of 450 or less
3. CAN/ULC-S102.2 – Flame Spread Rating and Smoke Developed – Results as tested.

1.05 DELIVERY, STORAGE & HANDLING

A. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Include the manufacturer's maintenance instructions for flooring and accessories.

B. Store materials in a clean, dry, enclosed space off the ground, protected from harmful weather conditions and at temperature and humidity conditions recommended by the manufacturer. Protect adhesives from freezing. Store flooring, adhesives, and accessories in the spaces where they will be installed for at least 48 hours before beginning installation.

1.06 WARRANTY

A. Floor product will be warranted to be free from manufacturing defects for five (5) years from date of substantial completion.

1.07 MAINTENANCE

A. Extra Materials: Deliver extra materials to the Owner. Furnish extra materials from the same production run as the products installed. Packaged with protective covering for storage and identified with appropriate labels.

1. Quantity: Furnish quantity of flooring units equal to 1 % of the amount installed.
2. Delivery, Storage and Protection: Comply with the Owner's requirements for delivery, storage, and protection of extra material.

PART 2 PRODUCTS

2.01 RESILIENT TILE MODULAR FLOORING

A. Manufacturer: Armstrong- Standard Excelon Imperial Texture, or approved equal

1. Contact: P.O. Box 3001, Lancaster, PA 17604, 1.877.ARMSTRONG, www.armstrong.com

B. Armstrong Standard Excelon:

1. Size: 12 inches × 12 inches (305 mm × 305 mm).
2. Gauge: 1/8 inch (3.2 mm).
3. Recovery from Long-Term Indentation (ASTM F970): 125 PSI.
4. Pattern and Color: As selected by the Architect from the manufacturer's standard patterns and colors.

C. Latex Patching Compound: ASTM F710.

D. Adhesive: As recommended by manufacturer only. No substitutions

PART 3 EXECUTION

3.01 3.01 MANUFACTURER’S INSTRUCTIONS

A. Compliance: Comply with manufacturer’s product data, including technical bulletins, product catalog, installation instructions, and product carton instructions for installation and maintenance procedures as needed.

3.02 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions (i.e., moisture tests, bond test, pH test, etc.).

B. Visually inspect flooring materials, adhesives, and accessories prior to installation. Flooring material with visual defects shall not be installed and shall not be considered as a legitimate claim.

C. Examine subfloors prior to installation to determine that surfaces are smooth and free from cracks, holes, ridges, and other defects that might prevent adhesive bond or impair durability or appearance of the flooring material.

D. Inspect subfloors prior to installation to determine that surfaces are free from curing, sealing, parting and hardening compounds; residual adhesives; adhesive removers; and other foreign materials that might prevent adhesive bond. Visually inspect for evidence of moisture, alkaline salts, carbonation, dusting, mold, or mildew.

E. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.

F. Failure to call attention to defects or imperfections will be construed as acceptance and approval of the subfloor. Installation indicates acceptance of substrates regarding conditions existing at the time of installation.

3.03 PREPARATION

A. [Subfloor Preparation: Smooth concrete surfaces, removing rough areas, projections, ridges, and bumps, and filling low spots, control or construction joints, and other defects with Armstrong Flooring [S-194 Cement-Based Patch, Underlayment and Embossing Leveler / S-195 Underlayment Additive] [S-463 Level Strong™ cement based self-leveling compound] [S-466 Patch Strong™ patching and smoothing compound] [S-464 Prime Strong™ acrylic primer for porous substrates] [S-465 Prime Strong™ epoxy primer for non-porous substrates] as recommended by the flooring manufacturer. Refer to Armstrong Flooring Guaranteed Installation Systems and ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring for additional information on subfloor preparation.]

B. [Subfloor Preparation Moisture Mitigation: Smooth concrete surfaces, removing rough areas, projections, ridges, and bumps, and filling low spots, control or construction joints, mitigate moisture and other defects with Armstrong Flooring [S-194 Cement-Based Patch, Underlayment and Embossing Leveler / S-195 Underlayment Additive] [S-463 Level Strong™ cement based self-leveling compound] [S-466 Patch Strong™ patching and smoothing compound] [S-462 Seal Strong™ two-part moisture mitigation system] [S-464 Prime Strong™ acrylic primer for porous substrates] [S-465 Prime Strong™ epoxy primer for non-porous substrates] as recommended by the flooring manufacturer. Refer to Armstrong Flooring Guaranteed Installation Systems and ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring for additional information on subfloor preparation.]

C. Subfloor Cleaning: The surface shall be free of dust, solvents, varnish, paint, wax, oil, grease, sealers, release agents, curing compounds, residual adhesive, adhesive removers, and other foreign materials that might affect the adhesion of resilient flooring to the concrete or cause a discoloration of the flooring from below. Remove residual adhesives as recommended by the flooring manufacturer. Remove curing and hardening compounds not compatible with the adhesives used, as indicated by a bond test or by the compound manufacturer's recommendations for flooring. Avoid organic solvents. Spray paints, permanent markers and other indelible ink markers must not be used to write on the back of the flooring material or used to mark the concrete slab as they could bleed through, telegraphing up to the surface and permanently staining the flooring material. If these contaminants are present on the substrate, they must be mechanically removed prior to the installation of the flooring material. Refer to the Armstrong Flooring Guaranteed Installation Systems and ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring for additional information on subfloor preparation.

D. [For Tile High-Moisture Installation Warranty when using S-515 Adhesive, perform subfloor moisture testing in accordance with [ASTM F 2170, “Standard Test Method for Determining Relative Humidity in Concrete Slabs Using *in situ* Probes”][ASTM F 1869,“Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride”] and Bond Tests as described in the Armstrong Flooring Guaranteed Installation Systems, to determine if surfaces are dry; free of curing and hardening compounds, old adhesive, and other coatings; and ready to receive flooring. [Relative humidity shall not exceed 95%.] [MVER shall not exceed 7 lbs./1000 sq. ft./24 hrs.] On installations where both the Percent Relative Humidity and the Moisture Vapor Emission Rate tests are conducted, results for both tests shall comply with the allowable limits listed above. Do not proceed with flooring installation until results of moisture tests are acceptable. All test results shall be documented and retained].

E. [For Tile High-Moisture Installation Warranty when using S-525 Adhesive, perform subfloor moisture testing in accordance with [ASTM F 2170, “Standard Test Method for Determining Relative Humidity in Concrete Slabs Using *in situ* Probes”][ASTM F 1869,“Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride”] and Bond Tests as described in the Armstrong Flooring Guaranteed Installation Systems, to determine if surfaces are dry; free of curing and hardening compounds, old adhesive, and other coatings; and ready to receive flooring. [Relative humidity shall not exceed 90%.] [MVER shall not exceed 7 lbs./1000 sq. ft./24 hrs.] On installations where both the Percent Relative Humidity and the Moisture Vapor Emission Rate tests are conducted, results for both tests shall comply with the allowable limits listed above. Do not proceed with flooring installation until results of moisture tests are acceptable. All test results shall be documented and retained.

F. [When using S-1000 Adhesive, perform subfloor moisture testing in accordance with [ASTM F 2170, “Standard Test Method for Determining Relative Humidity in Concrete Slabs Using *in-situ* Probes”] [ASTM F 1869,“Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride”] and Bond Tests as described in "Armstrong Flooring Guaranteed Installation System" instructions to determine if surfaces are dry; free of curing and hardening compounds, old adhesive, and other coatings; and ready to receive flooring. [Internal relative humidity of the concrete shall not exceed 100%.] [MVER shall not exceed 14 lbs./1000 sq. ft./24 hrs.] On installations where both the Percent Relative Humidity and the Moisture Vapor Emission Rate tests are conducted, results for both tests shall comply with the allowable limits listed above. Do not proceed with flooring installation until results of moisture tests are acceptable. All test results shall be documented and retained].

G. Concrete pH Testing: Perform pH tests on concrete floors regardless of their age or grade level. All test results shall be documented and retained.

3.04 INSTALLATION OF FLOORING

A. Install flooring wall to wall before the installation of floor-set cabinets, casework, furniture, equipment, movable partitions, etc. Extend flooring into toe spaces, door recesses, closets, and similar openings as shown on the drawings.

B. Scribe, cut, and fit to permanent fixtures, columns, walls, partitions, pipes, outlets, and built-in furniture and cabinets.

C. Install flooring with adhesives, tools, and procedures in strict accordance with the manufacturer's written instructions. Observe the recommended adhesive trowel notching, open times, and working times.

3.05 INSTALLATION OF ACCESSORIES

A. Apply top set wall base to walls, columns, casework, and other permanent fixtures in areas where top-set base is required. Install base in lengths if practical, with inside corners fabricated from base materials that are mitered or coped. Tightly bond base to vertical substrate with continuous contact at horizontal and vertical surfaces.

B. Fill voids with plastic filler along the top edge of the resilient wall base or integral cove cap on masonry surfaces or other similar irregular substrates.

C. Place resilient edge strips tightly butted to flooring, and secure with adhesive recommended by the edge strip manufacturer. Install edge strips at edges of flooring that would otherwise be exposed.

D. Apply overlap metal edge strips where shown on the drawings, before flooring installation. Secure units to the substrate, complying with the edge strip manufacturer's recommendations.

3.06 CLEANING

A. Perform initial and on-going maintenance according to the latest edition of the Maintenance Instructions for Vinyl Composition.

3.07 PROTECTION

A. Protect installed flooring as recommended by the flooring manufacturer against damage from rolling loads, other trades, or the placement of fixtures and furnishings.

END OF SECTION 09 65 19

SECTION 09 68 13 00 - CARPET TILE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for carpet tile. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes carpet tile.

C. Submittals
   1. Product Data: For each product indicated.
   2. Shop Drawings: Show the following:
      a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
      b. Existing flooring materials to be removed.
      c. Existing flooring materials to remain.
      d. Carpet tile type, color, and dye lot.
      e. Type of subfloor.
      f. Type of installation.
      g. Pattern of installation.
      h. Pattern type, location, and direction.
      i. Pile direction.
      j. Type, color, and location of insets and borders.
      k. Type, color, and location of edge, transition, and other accessory strips.
      l. Transition details to other flooring materials.
   3. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
      a. Carpet Tile: Full-size Sample.
      b. Exposed Edge, Transition, and other Accessory Stripping: 12-inch long samples.
   4. LEED Submittal:
      a. Product Data for Credit EQ 4.3:
         1) For carpet tile, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.
         2) For installation adhesive, including printed statement of VOC content.
   5. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
   6. Maintenance data.

D. Quality Assurance
   1. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
   2. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

E. Delivery, Storage, And Handling
   1. Comply with CRI 104, Section 5, "Storage and Handling."

F. Project Conditions
   1. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

2. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
3. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
4. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

G. Warranty
1. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
    a. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
    b. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
    c. Warranty Period: 10 years from date of Substantial Completion.

1.2 PRODUCTS

A. Carpet Tile –Commercial-grade - Interface, Mohawk, Mannington, Bentley or Patcraft or equal
1. Fiber Content: 100 percent nylon 6,
2. Fiber Type:
3. Pile Characteristic: Multi Level-loop
4. Yarn Twist: As Approved by University.
5. Yarn Count: As Approved by University.
6. Density: As Approved by University.
7. Pile Thickness: finished carpet tile per ASTM D 6859.
8. Stitches: As Approved by University.
9. Gage: As Approved by University.
10. Surface Pile Weight: As Approved by University.
11. Total Weight: for finished carpet tile.
12. Primary Backing/Backcoating: Ecoworx
13. Secondary Backing: Manufacturer's standard material.
14. Backing System: Ecoworx
15. Size: per manufacturer
16. Applied Soil-Resistance Treatment: Manufacturer's standard material.
17. Antimicrobial Treatment: Manufacturer's standard material.
18. Performance Characteristics: As follows:
    a. Critical Radiant Flux Classification: Not less than0.45 W/sq. cm
    b. Dry Breaking Strength: Not less than 100 lbf per ASTM D 2646.
    c. Tuft Bind: Not less than 8 lbf, per ASTM D 1335.
    d. Delamination: Not less than 4 lbf/in. per ASTM D 3936.
    e. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
    f. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
    g. Resistance to Insects: Comply with AATCC 24.
    h. Noise Reduction Coefficient (NRC): per ASTM C 423.
    i. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
    j. Colorfastness to Light: Not less than 4 after 60, AFU (AATCC fading units) per AATCC 16, Option E.

- k. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
- l. Electrostatic Propensity: Less than 3.5 kV per AATCC 134.
- m. Environmental Requirements: Provide carpet tile that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

B. Installation Accessories

1. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
2. Adhesives:

Note: MUST USE ADHESIVE RECOMMENDED BY THE CARPET TILE MANUFACTURER OF THE PRODUCT BEING INSTALLED. Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer.

- a. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).

1.3 EXECUTION

A. Preparation

1. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
3. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
4. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
5. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

B. Installation

1. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
2. Installation Method: As recommended in writing by carpet tile manufacturer install every tile with full-spread, releasable, pressure-sensitive adhesive
3. Maintain dye lot integrity. Do not mix dye lots in same area.
4. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
5. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
7. Install pattern parallel to walls and borders.
8. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

C. Cleaning And Protection

1. Perform the following operations immediately after installing carpet tile:
   a. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
   b. Remove yarns that protrude from carpet tile surface.
   c. Vacuum carpet tile using commercial machine with face-beater element.
2. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."
3. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13 0068 13 00

SECTION 09 91 13 00 – PAINTING EXTERIOR

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Refer to Specification Section 09 91 23 for all which is directly applicable.

1.02-1.04 (Reference 09 91 23)

1.05 SUBMITTALS

A. Field Protection Plan: the contractor shall provide a plan of action and a list of methods they intend to use to protect the equipment in the field from any on-site painting. This shall be in the form of a “Action Plan” that clearly defines the method in which the paint will be applied and the methods that will be used to protect the existing equipment from overspray, protection for paint entering the cooling towers intake louvers and protection of any adjacent equipment.

B. Samples:
  1. Samples for initial color selection in the form of manufacturer's color charts.
    a. After color selection, the Architect will furnish color chips for surfaces to be coated.
  2. Samples for verification purposes:
    a. Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.
    b. Define each separate coat, including block fillers and primers.
    c. Use representative colors when preparing samples for review
    d. Resubmit until required sheen, color, and texture are achieved.
    e. Provide a list of material and application for each coat of each sample. Label each sample as to location and application.
    f. Submit samples on the following substrates for the Architect's review of color and texture only:
      1) Pipe: Provide two samples of a small section of 4” diameter pipe with color for condenser water piping.
      2) Concrete Masonry: Provide two 4 by 8-inch samples of masonry, with mortar joint in the center, for each finish and color.
      3) Painted Wood: Provide two 12-by-12-inch samples of each color and material on hardboard.
      4) Ferrous Metal: For non-pipe metals, provide two 4-inch square samples of flat metal and two 8-inch-long samples of solid metal for each color and finish.
      6) Drywall: Provide two 12-by-12-inch samples of each color and finish.

1.06 – 2.02 (Reference 09 91 23)

2.03 MECHANICAL EQUIPMENT PAINT SCHEDULE

A. Provide the following paint systems for the various substrates, as indicated. Provide only the listed prime and finish coat materials unless otherwise recommended in writing by the paint manufacturer for each specific substrate.

B. Where specific finish paint material is not indicated, refer to notes and finish schedules for finish paint material and gloss levels for each surface to be painted.

C. The following mechanical systems / piping shall be painted: See section 2.4 below:

1. Condenser Water Piping and fittings – Color Green to match existing.
2. Chilled Water Piping and fittings – Zinc Primer, prior to insulation.
3. Condenser Filtration Piping, Makeup Water Piping & Recycled Water Piping and Fittings – Color Green to match existing.
4. Valves – Steel valve body shall be painted to match the system it belongs to. Brass and Bronze valve bodies shall not be painted.

2.04 EXTERIOR PAINT SCHEDULE

A. Condenser Water Piping, Drain Piping, Filtration Piping and Makeup Water Piping shall receive the following paint finish.

1. Paint Material shall be by Sherwin Williams.
2. Surface preparation: SPC-SP10 Near White Metal Blast.
3. Prime Coat: Zinc Clad 4100 Organic Zinc Epoxy Primer by Sherwin Williams. 3-5 mils DFT.
4. Stripe Coat: Sher-Loxane 800 Polysiloxane by Sherwin Williams. Stripe coating shall be applied at all welded seams.
5. Top Coat: Sher-Loxane 800 Polysiloxane by Sherwin Williams. 4-6 mils DFT.

B. Chilled Water Piping Primer:

1. Provide primer coat: Primer Coat shall be equal to Polyguard type “RG-CHW” applied in accord with Manufacturers Published Requirements on all piping, to include field welds and over factory applied paint/coating, in total compliance with Contract Documents and compatible with and approved by the insulation manufacturer. Painting must be completed and approved prior to installation of insulation. Paint shall be applied in accordance with the paint manufacturer’s instructions, environment, and pipe surface temperatures.

C. Hot Dipped Galvanized Metal; No paint required.

D. Traffic & Zone Products

1. Sherwin Williams SETFAST® Solvent Based Acrylic Zone Marking Paint:
   a. TM5632 White
   b. TM5645 Lead-Free Yellow.

3.01 – 3.05 (Reference 09 91 23)

3.06 PROTECTION

A. It is of the utmost importance that all existing equipment (Cooling Towers) be protected from any painting being performed on site. The contractor will protect all cooling tower and related equipment from overspray. Protect Work of other trades, whether to be painted or not, against damage by painting.

B. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect.

C. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their Work after completion of painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 09 91 13

SECTION 09 91 23 00 – PAINTING INTERIOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 definitions

A. "Paint" includes coating systems materials; primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

1. Substrate" as used herein means the surface to which paint is to be applied. In the case of previously painted existing surfaces, substrate means the surface to which the existing paint was applied.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

C. Notify the Architect of problems anticipated using the materials specified.

D. Material Quality: Provide the manufacturer's best quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude equal products of other manufacturers.

2. Federal Specifications establish a minimum quality level for paint materials, except where other product identification is used. Provide written certification from the manufacturer that materials provided meet or exceed these criteria.

3. Products that comply with qualitative requirements of applicable Federal Specifications, yet differ in quantitative requirements, may be considered for use when acceptable to the Architect. Furnish material data and manufacturer's certificate of performance to Architect for proposed substitutions.

1.01.1.1.1.1 Odor Eliminating Additive: At all locations scheduled to receive solvent or alkyd-based coatings, provide an odor-eliminating additive to minimize the presence of odor from wet and drying paint films.

4. Provide additive recommended and approved by the primer/finish coat manufacturer for use with their paint. Benjamin Moore does not recommend an “odor eliminator additive” for Benjamin Moore Paints.

5. Provided compliance with above requirements, "Bio Zapp Paint Odor Eliminator" by Bio Zapp Laboratories, (800/776-7721) is acceptable.

1.5 SUBMITTALS

A. Samples:

1. Samples for initial color selection in the form of manufacturer's color charts.

2. Samples for verification purposes:

   a. Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

   b. Resubmit until required sheen, color, and texture are achieved.

   c. Provide a list of material and application for each coat of each sample. Label each sample as to location and application.

   d. Submit samples on the following substrates for the Architect's review of color and texture only:

      1) Concrete: Provide two 4 inch square samples for each color and finish, or provide field sample as determined by architect.

      2) Concrete Masonry: Provide two 4 by 8 inch samples of masonry, with mortar joint in the center, for each finish and color, or provide field sample as determined by architect.

      3) Painted Wood: Provide two 12 by 12 inch samples of each color and material on hardboard.

      4) Stained or Natural Wood: Provide two 4 by 8 inch samples of natural and stained wood finish on actual wood surfaces.

      5) Ferrous Metal: Provide two 4 inch square samples of flat metal and two 8 inch long samples of solid metal for each color and finish, or provide field sample as determined by architect.

      6) Drywall: Provide two 12 by 12-inch samples of each color and finish.

1.6 DELIVERY, STORAGE and HANDLING

A. Deliver materials to the Project Site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.

2. Product description (generic classification or binder type).

3. Federal Specification number, if applicable.

4. Manufacturer's stock number and date of manufacture.

5. Contents by volume, for pigment and vehicle constituents, and VOC content.

6. Thinning instructions.
7. Application instructions.
8. Color name and number.

1.01.1.1.1.2 Store materials not in use in tightly covered containers in a well ventilated area at a minimum ambient temperature of 45 degrees F (7 degrees C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

9. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and Work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 project conditions

A. Apply water based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C).

B. Apply solvent thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C).

C. Do not apply paint in snow, rain, fog, or mist, when the relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.

   1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 PAINTING MANUFACTURES

A. Sherwin-Williams

   1. Website: www.sherwin-williams.com
   2. Address:3453 Fredericksburg Rd, San Antonio, TX 78201-3848

1.01.1.1.1.3 PPG Paints

B. Or Approved Equal

   1.

2.3 PAINT SCHEDULE

A. Provide the following paint systems for the various substrates, as indicated. Provide only the listed prime and finish coat materials unless otherwise recommended in writing by the paint manufacturer for each specific substrate.

B. Where specific finish paint material is not indicated, refer to notes and finish schedules for finish paint material and gloss levels for each surface to be painted.

2.4 INTERIOR PAINTING SCHEDULE

A. Gypsum Drywall; two (2) finish coats over primer.
  1. Primer:
    a. SW B28W08020 – PVA INT PRMR WHITE
  2. Finish Coat:
    a. SW B31W02651 – ProMar 200 Zero VOC Interior Latex Semi-Gloss

B. Plaster; two (2) finish coats over primer:
  1. Primer:
    a. SW LX02W0050 – LXN C&M PRIME WH
  2. Finish Coat:
    a. SW B31W02651 – ProMar 200 Zero VOC Interior Latex Semi-Gloss

C. Steel/Ferrous Metal; two (2) finish coats over primer:
  1. Primer:
    a. SW B66W01310 – PI PROCRYL PR OF W
  2. Finish Coat:
    a. SW B66W00651 – Pro Industrial High-Performance Acrylic – Semi-Gloss

D. Wood - Interior; two (2) finish coats over prime coat.
  1. Primer:
    a. SW B79W08810 – ProBlock Interior Oil-Based Primer White
  2. Finish Coat:
    a. SW B31W02651 – ProMar 200 Zero VOC Interior Latex Semi-Gloss

E. Drywall-Vapor Barrier; two (2) finish coats over prime coat
  1. Primer:
    a. SW B72W00011 – MOIST VAPR BAR
  Finish Coat:
    a. SW B31W02651 – ProMar 200 Zero VOC Interior Latex Semi-Gloss

F. Fire-Retardant-Metal; two (2) finish coats
  1. Finish Coat:
    a. SW 04043238 – Flame Control No. 10-10 Flat Alkyd Type Intumescent Fire Retardant Paint

G. Floor Sealer; two (2) finish coats
  1. Finish Coat:
    a. SW 50.170155 – CLPRO HIPRF CLR COAT

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.

  1. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

1.01.1.1.1.4 General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.

2. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

1.01.1.1.1.5 Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.

3. Provide barrier coats over incompatible primers and existing surfaces, or remove and reprime. Notify Architect in writing of problems anticipated with using the specified finish coat material with substrates primed by others.

4. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral fiber reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

   a. Use abrasive blast cleaning methods if recommended by the paint manufacturer.

   b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.

   c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, and rinse; allow to dry and vacuum before painting.

5. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

   a. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer before application of primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.

   b. Prime, stain, or seal wood to be painted immediately upon delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases, and paneling.

   c. When transparent finish is required, backprime with spar varnish.

   d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.

   e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately upon delivery.

6. Ferrous Metals: Clean nongalvanized ferrous metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council.

   a. Blast steel surfaces clean as recommended by the paint system manufacturer and in accordance with requirements of SSPC specification SSPC SP 10.

   b. Touch up bare areas and shop applied prime coats that have been damaged. Wire brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

7. Galvanized Surfaces: Clean galvanized surfaces with non petroleum based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

8. Wood-Interior: All surfaces must be sanded smooth, with the grain, never across it. Surface blemishes must be corrected and area cleaned of dust before coating. Patching compounds will generally be visible through clear coatings.

1.01.1.1.1.6 Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.

9. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

10. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.

11. Use only thinners approved by the paint manufacturer, and only within recommended limits.

1.01.1.1.1.7 Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.3 APPLICATION

A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

B. Paint exposed surfaces whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.

1. Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron Work, primed surfaces of mechanical, electrical, and all other equipment, and prefinished surfaces of certain equipment including, but not limited to; electrical panel covers, equipment supports, and equipment exposed to view on the roof.

1.01.1.1.1.8 At "unoccupied" interior areas, painting is not required on prefinished items or finished metal surfaces.

2. Do not paint over Underwriter's Laboratories, Factory Mutual or other code required labels or equipment name, identification, performance rating, or nomenclature plates.

1.01.1.1.1.9 Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

3. Paint colors, surface treatments, and finishes are indicated in "schedules."

4. Provide finish coats that are compatible with primers used.

5. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.

6. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.

7. The term "exposed surfaces" includes areas visible when permanent or built in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.

8. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.

9. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, nonspecular black paint.

10. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

11. Finish interior of wall and base cabinets and similar field finished casework to match exterior.

12. Finish exterior doors on tops, bottoms, and side edges same as exterior faces.

13. Sand lightly between each succeeding enamel or varnish coat.

14. Omit primer on metal surfaces that have been shop primed and touch up painted.

1.01.1.1.1.10 Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

15. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

1.01.1.1.1.11 Minimum Coating Thickness: Apply materials at not less than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the manufacturer.

C. Mechanical and Electrical Work: Painting mechanical and electrical Work is limited to items exposed in mechanical equipment rooms and in occupied spaces.

D. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

1. Prime Coats: Before application of finish coats, apply a prime coat of material as recommended by the manufacturer to material that is required to be painted or finished and has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to assure a finish coat with no burn through or other defects due to insufficient sealing.

1.01.1.1.1.12 Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling such as laps, irregularity in texture, skid marks, or other surface imperfections.

E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

F. Transparent (Clear) Finishes: Use multiple coats to produce a glass smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections.

1. Provide satin finish for final coats.

1.01.1.1.1.13 Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements.

3.4 FIELD QUALITY CONTROL

A. UT Health reserves the right to invoke the following test procedure at any time and as often as it deems necessary during the period when the paint is being applied:

1. UT Health will engage the services of an independent testing laboratory to sample the paint material being used. Samples of material delivered to the project will be taken, identified, sealed, and certified in the presence of the Contractor.

2. The testing laboratory will perform appropriate tests for the following characteristics as required by The University:

   a. Quantitative materials analysis

   b. Abrasion resistance

   c. Apparent reflectivity

   d. Flexibility

   e. Wash ability

   f. Absorption

   g. Accelerated weathering

   h. Dry opacity

   i. Accelerated yellowness

   j. Recoating

   k. Skinning

   l. Color retention

   m. Alkali and mildew resistance

3. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove noncomplying paint, pay for testing, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are noncompatible.

3.5 CLEANING

A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the Project Site.

B. Upon completion of painting, clean glass and paint spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

3.6 PROTECTION

A. Protect Work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect.

B. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their Work after completion of painting operations.

    1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 09 91 23 00

SECTION 10 11 00 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who is an authorized representative of the manufacturer for both installation and maintenance of the type of sliding markerboard units required for this Project.

1. Maintenance Proximity: Not more than four hours normal travel time from the Installer's place of business to the Project Site.

1.01.1.1.1.1 Fire Performance Characteristics: Provide vinyl fabric faced tackboards with surface burning characteristics indicated below, as determined by testing assembled materials composed of facings and backings identical to those required in this section, in accordance with ASTM E 84, by a testing organization acceptable to authorities having jurisdiction.

2. Flame Spread: 25 or less

3. Smoke Developed: 10 or less

1.01.1.1.1.2 Design Criteria:

4. The Drawings indicate sizes, profiles, and dimensional requirements of visual display boards and are based on the specific type and model indicated.

5. Other visual display boards having equal performance characteristics with deviations from indicated dimensions and profiles may be considered, provided that deviations in dimensions and profiles are minor and do not change the design concept or intended performance as judged by the Architect. The burden of proof of equality is on the proposer.

1.4 SUBMITTALS

A. Product Data:

1. Include motor capacities, and individual panel weights for sliding markerboard or markerboard units. Include manufacturer's data substantiating that tackboard materials comply with requirements indicated.

2. In lieu of laboratory test reports, when permitted by the Architect, submit the manufacturer's certification that tackboard materials furnished comply with requirements specified for flame spread ratings.

1.01.1.1.1.3 Samples:

3. Samples for initial selection of color, pattern, and texture:

   a. Porcelain Enamel Markerboard: Manufacturer's color charts consisting of actual sections of porcelain enamel finish showing the full range of colors available for each type of markerboard required.

   b. Vinyl fabric faced Cork Tackboards: Manufacturer's color charts consisting of actual sections of vinyl fabric, showing the full range of colors, textures, and patterns available for each type of vinyl fabric faced cork tackboard indicated.

   c. Aluminum Trim and Accessories: .

4. Samples for verification of color, pattern, and texture selected, and compliance with requirements indicated.

   a. Markerboards, and Tackboards: Sample panels not less than 8-1/2 inches by 11 inches for each type of markerboard and tackboard indicated. Include a sample panel for each color, texture, and pattern required.

   b. Aluminum Trim and Accessories: Samples of each finish type and color, on 6 inch long sections of extrusions and not less than 4 inch squares of sheet or plate. Where finishes involve normal color and texture variations, include sets showing the full range of variations expected.

B. Shop Drawings:

1. Shop Drawings: Provide shop drawings for each type of markerboard and tackboard required. Include sections of typical trim members and dimensioned elevations. Show anchors, grounds, reinforcement, accessories, layout, and installation details.

1.5 WARRANTY

A. Porcelain Enamel Markerboard Warranty: Furnish the manufacturer's written warranty, agreeing to replace porcelain enamel markerboards that do not retain their original writing and erasing qualities, become slick and shiny, or exhibit crazing, cracking, or flaking, provided the manufacturer's instructions with regard to handling, installation, protection, and maintenance have been followed.

1. Warranty Period: 50 years.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. Subject to compliance with requirements, manufacturers offering products may be incorporated in the Work include, but are not limited to, the following:

1. Porcelain Enamel Markerbords:

   a. Claridge Products and Equipment, Inc.

   b. Or Approved equal

2. Tackboards:

   a. Claridge Products and Equipment, Inc.

   b. Or approved Equal

1.01.1.1.1.3.1 MATERIALS

B. Porcelain Enamel Markerboards: Provide balanced, high pressure laminated porcelain enamel markerboards of 3 ply construction consisting of face sheet, core material, and backing.

1. Face Sheet: Provide face sheet of 24 gage enameling grade steel especially processed for temperatures used in coating porcelain on steel. Coat the exposed face and exposed edges with a 3 coat process consisting of primer, ground coat, and color cover coat, and the concealed face with a 2 coat process consisting of primer and ground coat. Fuse cover and ground coats to steel at the manufacturer's standard firing temperatures, but not less than 1200 degrees F (649 degrees C).

   a. Cover Coat: Provide the manufacturer's standard light colored special writing surface with gloss finish intended for use with liquid felt tipped markers.

2. Core: Provide the manufacturer's standard 3/8 inch thick particleboard core material complying with the requirements of ANSI A208.1, Grade 1 M 1.

3. Core: Provide the manufacturer's standard 1/4 inch thick tempered hardboard core material.

4. Core: Provide the manufacturer's standard 3/8 inch heavy kraft paper honeycomb core material.

5. Backing Sheet: Provide the manufacturer's standard 26 gage galvanized steel sheet backing.

6. Laminating Adhesive: Provide the manufacturer's standard moisture resistant thermoplastic type adhesive.

2.3 ACCESSORIES

A. Metal Trim and Accessories: Fabricate frames and trim of not less than 0.062 inch thick aluminum alloy, size and shape as indicated, to suit type of installation. Provide straight, single length units wherever possible; keep joints to a minimum. Miter corners to a neat, hairline closure.

1. Where the size of boards or other conditions exist that require support in addition to the normal trim, provide structural supports or modify the trim as indicated or as selected by the Architect from the manufacturer's standard structural support accessories to suit the condition indicated.

2. Field Applied Trim: Provide the manufacturer's standard snap on trim, with no visible screws or exposed joints.

3. Chalktray: Furnish manufacturer's standard continuous box type aluminum chalktray with slanted front and cast aluminum end closures for each markerboard.

   a. Provide one box, 4 colors minimum, of liquid felt tip markers for each individual markerboard installed.

4. Map Rail: Furnish map rail at the top of each unit, complete with the following accessories:

   a. Display Rail: Provide continuous cork display rail approximately 1 or 2 inches wide, as indicated, integral with the map rail.

   b. End Stops: Provide one end stop at each end of the map rail.

   c. Map Hooks: Provide 2 map hooks with flexible metal clips for each 4 feet of map rail or fraction thereof.

1.01.1.1.1.3.2 FABRICATION

B. Porcelain Enamel Markerboards: Laminate facing sheet and backing sheet to core material under pressure with manufacturer's recommended flexible, waterproof adhesive.

C. Assembly: Provide factory assembled markerboard and tackboard units, except where field assembled units are required.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with the minimum number of joints, balanced around the center of the board, as acceptable to the Architect.

2. Provide the manufacturer's standard vertical joint system between abutting sections of markerboard.

3. Provide manufacturer's standard mullion trim at joints between markerboard and tackboard.

1.01.1.1.1.4 Unit Sizes: Provide markerboard and tackboard units in lengths shown on Drawings and, unless otherwise indicated, in a constant 42 inch height.

2.4 FINISHES

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

B. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.

C. Class II Clear Anodized Finish: AA M12C22A31 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, clear film thicker than 0.4 mil).

D. Class II Color Anodized Finish: AA M12C22A32/A34 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, film thicker than 0.4 mil with integral color or electrolytically deposited color).

1. Color: Light bronze

2. Color: Medium bronze

3. Color: Dark bronze

4. Color: Black

5. Color: Match Architect's sample.

6. Color: As selected by Architect from within standard industry colors and color density range.

1.01.1.1.1.5 Baked Enamel Finish: AA C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate fluoride phosphate pretreatment; Organic Coating: as specified below). Apply baked enamel in compliance with paint manufacturer's specifications for cleaning, conversion coating, and painting.

7. Organic Coating: Thermosetting modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with minimum dry film thickness of 1.5 mils, medium gloss.

8. Color: As indicated by reference to manufacturer's standard color designations.

9. Color: Match Architect's sample.

10. Color: As selected by Architect from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Deliver factory built markerboard and tackboard units completely assembled in one piece without joints, wherever possible. Where dimensions exceed panel size, provide 2 or more pieces of equal length as acceptable to the Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site. Use splines at joints to maintain surface alignment.

D. Install units in locations and at mounting heights indicated and in accordance with the manufacturer's instructions. Keep perimeter lines straight, plumb, and level. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for a complete installation.

E. Coordinate job site assembled units with grounds, trim, and accessories. Join parts with a neat, precision fit.

3.2 ADJUST AND CLEAN

A. Verify that accessories required for each unit have been properly installed and that operating units function properly.

B. Clean units in accordance with the manufacturer's instructions. Break in markerboards only as recommended by the manufacturer.

END OF SECTION 10 11 00 00

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SECTION 10 21 13 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Solid Color Reinforced Composite (SCRC) Substrate: (Bobrick SierraSeries or equal).
   1. Toilet partitions.
   2. Urinal privacy screens.
   3. Dressing compartments.
   4. Shower dividers.

B. Compact Laminate (CL/Solid Phenolic), Moisture Resistant Substrate: (Bobrick DuraLineSeries or equal).
   1. Toilet partitions.
   2. Urinal privacy screens.
   3. Dressing compartments.
   4. Shower dividers.

C. High-Pressure Laminate (HPL) with Particle Board Substrate (Bobrick DesignerSeries or equal).
   1. Dressing compartments only.

D. High-Pressure Laminate (HPL) with Particle Board Substrate (Bobrick MetroSeries or equal).
   1. Dressing compartments only.

1.2 RELATED SECTIONS

A. Section 05 50 00 - Metal Fabrications.

B. Section 06 10 00 - Rough Carpentry.

C. Section 09 25 23 - Lime Based Plastering.

D. Section 09 33 00 - Conductive Tiling.

E. Section 09 51 23 - Acoustical Tile Ceilings.

F. Section 10 28 13.19 - Healthcare Toilet Accessories.

G. Section 10 28 13.19 - Healthcare Toilet Accessories.

1.3 SUBMITTALS

A. (NOT USED)

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. USGBC LEED Submittals:
   1. For Bobrick ClassicSeries, DesignerSeries and DuraLineSeries: Materials and Resource Credits MR4.1 and MR4.2 - Recycled Content; submit manufacturer's calculation of value of recycled content for specified products, calculated in accordance with USGBC LEED certification requirements.
   2. For Bobrick ClassicSeries and DesignerSeries: Materials and Resource Credit MR6 - Rapidly Renewable Materials; submit manufacturers certification that products contain raw materials that are derived from plants that are harvested within a 10 year cycle or shorter.
   3. For Bobrick SierraSeries: Indoor Environmental Quality Credit IEQ 4 - No Added Urea Formaldehyde; submit manufacturer's certification that composite and agrifiber products contain no added urea-formaldehyde resins and that laminating used to fabricate on-site and shop-applied composite wood and agrifiber contain no added urea-formaldehyde resins.
   4. For Bobrick SierraSeries: Indoor Environmental Quality Credit IEQ 4 for Schools; submit manufacturer's certification that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. USA Certificate of Origin: Manufacturer shall supply with first submittal, an example of their Certificate of Origin declaring toilet compartments are wholly manufactured and assembled specifically in the United States, including city and state locations. A notarized Certificate of Origin shall be provided with closeout documents.

E. Shop Drawings: Submit manufacturer's shop drawings for each product specified, including the following:
   1. Plans, elevations, details of construction and attachment to adjacent construction.
   2. Show anchorage locations and accessory items.
   3. Verify dimensions with field measurements prior to final production of toilet compartments.

F. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

G. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square representing actual product, color, and patterns.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 10 year experience manufacturing similar products.

B. Installer Qualifications: Minimum 2 year experience installing similar products.

C. Single Source Requirements: To the greatest extent possible provide products from a single manufacturer.

D. Accessibility Requirements: Comply with requirements applicable in the jurisdiction of the project, including but not limited to ADA and ICC/ANSI A117.1 requirements as applicable.

E. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish areas designated by Architect.
   2. Do not proceed with remaining work until workmanship is approved by Architect.
   3. Refinish mock-up area as required to produce acceptable work.

1.5 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

B. Handling: Handle materials to avoid damage.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.8 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.9 WARRANTY

A. Manufacturer's Warranty (SierraSeries and DuraLineSeries): Manufacturer's standard 25 year limited warranty for panels, doors, and stiles against breakage, corrosion, delamination, and defects in factory workmanship. Manufacturer's standard 1 year guarantee against defects in material and workmanship for stainless steel door hardware and mounting brackets.

B. Manufacturer's Warranty (DesignerSeries and MetroSeries): Manufacturer's standard 2 year warranty for materials and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Bobrick Washroom Equipment, Inc., which is located at: 6901 Tujunga Ave.; North Hollywood, CA 91605-6213; Tel: 818-764-1000; Fax: 818-765-2700; Email:info@bobrick.com; Web:www.bobrick.com

B. Basis of Design Products: Based on the quality and performance requirements of the project, specifications are based solely on the products of Bobrick Washroom Equipment, Inc. www.bobrick.com. The location of manufacturing shall be the United States.

C. Substitutions: The Architect will consider products of comparable manufacturers as a substitution, pending the Contractor's submission of adequate documentation of the substitution in accordance with procedures in Division 1 of the Project Manual. Documentation shall include a list of five similar projects of equivalent size where products have been installed for a minimum of two years, and manufacturer's certification that products are fabricated in the United States.

D. Requests for substitutions will be considered.

2.2 SOLID COLOR REINFORCED COMPOSITE (SCRC) SUBSTRATE

A. Solid Color Reinforced Composite (SCRC) Toilet Partitions
  1. Design Type:
    a. Standard Height.
      1) Door/Panel Height: 58 inches.
      2) Floor Clearance: 12 inches
    b. Maximum Height.
      1) Door/Panel Height: 71-3/4 inches .
      2) Floor Clearance: 4-1/2” inches.
  2. Privacy Style Partitions: No sightlines with gap-free interlocking doors and stiles routed 0.300 inches from the edge to allow for 0.175 inch overlap to prevent line-of-sight into the toilet compartment. Privacy strips fastened or adhered onto the partition material are not acceptable.
  3. Mounting:
    a. Floor-mounted.
      1) Stile Standard Height: 69 inches
      2) Stile Maximum Height: 75-3/16 inches .
    b. Floor-mounted, overhead-braced with extruded anodized aluminum headrails, 0.065 inch (1.65 mm) thick with anti-grip profile.
      1) Stile Maximum Height: 83 inches.
    c. Floor-to-ceiling.
      1) Stile Height: As required, 10 feet 0 inches maximum.
    d. Ceiling-hung.

            1) Stile Height: 8 feet 0 inches or as required 10 feet 0 inches maximum.

B. Solid Color Reinforced Composite (SCRC) Urinal Screens
    1. Mounting Configuration:
        a. Floor-to-ceiling.
            1) Screen Height: 58 inches with floor clearance: 12 inches.
            2) Stile Height: As required up to 10 feet 0 inches maximum.
        b. Floor-to-ceiling maximum privacy.
            1) Screen Height: 72 inches with floor clearance: 4-1/2 inches.
            2) Stile Height: As required up to 10 feet 0 inches maximum.
        c. Post-to-ceiling.
            1) Screen Height: 58 inches .
            2) Floor Clearance: 12 inches .
            3) Post Height: Up to 10 feet 0 inches maximum.
        d. Post-to-ceiling maximum privacy.
            1) Screen Height: 72 inches .
            2) Floor Clearance: 4-1/2 inches .
            3) Post Height: Up to 10 feet 0 inches maximum.
        e. Floor-anchored standard height
            1) Screen Standard Height: 58 inches with floor clearance: 12 inches
            2) Stile Standard Height: 69 inches
        f. Floor-anchored maximum height
            1) Screen Standard Height: 71-3/4 inches with floor clearance: 4- 1/2 inches
            2) Stile Standard Height: 75-3/16 inches

        g. Wall-hung.
            1) Screen Height: 42 inches with 18 inches floor clearance.
            2) Screen Height: 48 inches with 12 inches floor clearance.

C. Solid Color Reinforced Composite (SCRC) Dressing Compartments and/or Shower Dividers
    1. Design Type:
        a. Standard Height.
            1) Door/Panel Height: 58 inches.
            2) Floor Clearance: 12 inches.
        b. Maximum Height.
            1) Door/Panel Height: 71-3/4 inches.
            2) Floor Clearance: 4-1/2 inches.
    2. Privacy Style Partitions: No sightlines with gap-free interlocking doors and stiles routed 0.300 inches from the edge to allow 0.175 inch overlap to prevent line-of-sight into the toilet compartment. Privacy strips fastened or adhered onto the partition material are not acceptable.
    3. Mounting Configuration:
        a. Floor-mounted, overhead-braced with extruded anodized aluminum headrails, 0.065 inch thick with anti-grip profile and integral curtain tracks and hooks for compartments without doors.
            1) Bobrick vinyl curtains.
            2) Stile Height: 83 inches .

D. Materials: Solid color reinforced composite (SCRC) material for stiles, panels, doors, and screens with Bobrick GraffitiOff coating, thermoset and integrally fused into homogenous piece; high density polyethylene (HDPE), high density polypropylene not acceptable.
   1. Composition: Dyes, organic fibrous material, and polycarbonate/phenolic resins.
   2. Surface Treatment: Non-ghosting, graffiti resistant surface integrally bonded to core through a manufacturing steps requiring thermal and mechanical pressure.
   3. Edges: Same color as the surface.
   4. Color:
      a. As selected by Architect from manufacturer's standard SierraSeries range.
      b. As indicated on Drawings.
      c. SC01 Golden Khaki.
      d. SC02 Desert Beige.
      e. SC03 Terra Cotta.
      f. SC04 Forest Green.
   5. Acceptable SCRC Products: Or manufacturer approved equal.
      a. Ultimate Corian System by Shower Shapes.
      b. WilsonArt Gibraltar Material.
      c. WilsonArt EarthStone Material.

E. Performance Requirements:
   1. Graffiti Resistance (ASTM D 6578): Passed cleanability test; 5 staining agents.
   2. Scratch Resistance (ASTM D 2197): Maximum load value exceeds 10 kilograms.
   3. Impact Resistance (ASTM D 2794): Maximum impact force exceeds 30 inch-pounds.
   4. Smoke Developed Index (ASTM E 84): Less than 450.
   5. Flame Spread Index (ASTM E 84): Less than 75.
   6. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class B.
   7. Uniform Building Code: Class II.

F. Finished Thickness:
   1. Stiles and Doors: 3/4 inch .
   2. Panels and Screens: 1/2 inch.

G. Stiles: Floor-anchored stiles furnished with expansion shields and threaded rods.
   1. Leveling Devices: 7 gauge, 3/16 inches thick, corrosion-resistant, chromate- treated, double zinc-plated steel angle leveling bar bolted to stile; furnished with 3/8 inch diameter threaded rods, hex nuts, lock washers, flat washers, spacer sleeves, expansion anchors, and shoe retainers.
   2. Stile Shoes: One-piece, 22 gauge, 18-8, Type 304 stainless steel, 4 inch height; tops with 90 degree return to stile. One-piece shoe capable of adapting to 3/4 inch or 1 inch stile thickness and capable of being fastened (by clip) to stiles starting at wall line.

H. Wall Posts: Pre-drilled for door hardware, 18-8, Type 304, 16 gauge stainless steel with satin finish; 1 inch x 1-1/2 inches x 58 inches high.

I. Anchors: Expansion shields and threaded rods at floor connections as applicable. Threaded rods secured to supports above ceiling as applicable. Supports above ceiling furnished and installed as Work of Section 05 50 00 - Metal Fabrications.

J. Hardware: Chrome-plated "Zamak", aluminum, extruded plastic hardware not acceptable.
  1. Compliance: Operating force of less than 5 lbs.
  2. Emergency Access: Hinges, door latch allow door to be lifted over keeper from outside compartment on inswing doors.
  3. Materials: 18-8, Type 304, heavy-gauge stainless steel with satin finish.
  4. Doorstops: Prevents inswinging doors from swinging out beyond stile; on outswing doors, doorstop prevents door from swinging in beyond stile.
  5. Fastening: Hardware secured to door and stile by through-bolted, theft-resistant, pin- in-head Torx stainless steel machine screws into factory-installed, threaded brass inserts. Fasteners secured directly into core not acceptable.
    a. Threaded Brass Inserts: Factory-installed; withstand direct pull force exceeding 1500 lbs. per insert.
  6. Clothes Hooks: Projecting no more than 1-1/8 inch from face of door.
  7. Door Latch: Track of door latch prevents inswing doors from swinging out beyond stile; on outswing doors, door keeper prevents door from swinging in beyond stile; 16 gauge (1.6 mm) sliding door latch, 14 gauge keeper.
  8. Locking: Door locked from inside by sliding door latch into keeper.
  9. Hinge Type:
    a. Standard.
      1) Balanced, with field-adjustable cam to permit door to be fully closed or partially open when compartment is unoccupied.
    b. Full-Height Institutional Hinge.
      1) Hinges: 16 gauge stainless steel, self-closing, 3 section hinges.
  10. Mounting Brackets:
    a. Standard Concealed.
      1) Mounting Brackets: Mounted inside compartment; exposed brackets on exterior of compartment not acceptable with the exception of outswing doors.
    b. Full-Height.
      1) Mounting Brackets: 18 gauge stainless steel and extend full height of panel.
      2) U-Channels: Secure panels to stiles.
      3) Angle Brackets: Secure stiles-to-walls and panels to walls.

2.3 COMPACT LAMINATE (SOLID PHENOLIC), MOISTURE-RESISTANT SUBSTRATE

A. Compact Laminate (Solid Phenolic) Toilet Partitions
  1. Design Type::
    a. Standard Height.
      1) Door/Panel Height: 58 inches.
      2) Floor Clearance: 12 inches.
    b. Maximum Height.
      1) Door/Panel Height: 71-3/4 inches.
      2) Floor Clearance: 4-1/2 inches.
    c. Extended Height (available in gapless, full-height institutional hardware at the panel; overhead braced and floor to ceiling configurations only).

        1) Door/Panel Height: 96 inches.
        2) Floor Clearance: 1 inch.
2. Privacy Style Partitions: No sightlines with gap-free interlocking doors and stiles routed 0.300 inches (7.6 mm) from the edge to allow 0.175 inch (4.4 mm) overlap to prevent line-of-sight into the toilet compartment. Privacy strips fastened or adhered onto the partition material are not acceptable.
3. Mounting Configuration:
    a. Floor-mounted.
        1) Stile Standard Height: 69 inches;
        2) Maximum Height: 75-3/16 inches.
    b. Floor-mounted, overhead-braced with anodized aluminum headrails, 0.065 inch thick with anti-grip profile.
        1) Stile Maximum Height: 83 inches;
        2) Extended Height: 97 ¾ inches.
    c. Floor-to-ceiling.
        1) Stile Standard Height: As required, 10 feet 0 inches maximum.
    d. Ceiling-hung.
        1) Stile Standard Height: 8 feet 0 inches, or as required 10 feet 0 inches maximum.

B. Compact Laminate (Solid Phenolic) Urinal Screens
1. Mounting Configuration:
    a. Floor-anchored standard height
        1) Screen Standard Height: 58 inches with floor clearance: 12 inches .
        2) Stile Standard Height: 69 inches
    b. Floor-anchored maximum height
        1) Screen Standard Height: 71-3/4 inches with floor clearance: 4- 1/2” inches .
        2) Stile Maximum Height: 75-3/16 inches.
    c. Floor-to-ceiling.
        1) Screen Height: 58 inches with floor clearance: 12 inches.
        2) Stile Height: As required up to 10 feet 0 inches maximum.
    d. Floor-to-ceiling maximum privacy.
        1) Screen Height: 71-3/4 inches with floor clearance: 4-1/2 inches
        2) Stile Height: As required up to 10 feet 0 inches maximum.
    e. Post-to-ceiling.
        1) Screen Height: 58 inches.
        2) Floor Clearance: 12 inches.
        3) Post Height: Up to 10 feet 0 inches maximum.
    f. Post-to-ceiling maximum privacy.
        1) Screen Height: 71-3/4 inches.
        2) Floor Clearance: 4-1/2 inches.
        3) Post Height: Up to 10 feet 0 inches maximum.
    g. Wall-hung.
        1) Screen Height: 42 inches with 18 inches floor clearance.
        2) Screen Height: 48 inches with 12 inches floor clearance.

C. Compact Laminate (Solid Phenolic) Dressing Compartments and/or Shower Dividers
   1. Design Type:
      a. Standard Height.
         1) Door/Panel Height: 58 inches .
         2) Floor Clearance: 12 inches .
      b. Maximum Height.
         1) Door/Panel Height: 71-3/4 inches .
         2) Floor Clearance: 4-1/2 inches.
         3) Panels: Up to 71-3/4 inches wide, one piece. Splice or two panels joined by bracket not acceptable.

   2. Privacy Style Partitions: No sightlines with gap-free interlocking doors and stiles routed 0.300 inches (7.6 mm) from the edge to allow 0.175 inch (4.4 mm) overlap to prevent line-of-sight into the toilet compartment. Privacy strips fastened or adhered onto the partition material are not acceptable.

   3. Mounting Configuration:
      a. Floor-mounted, overhead-braced with extruded anodized aluminum headrails, 0.065 inch thick with anti-grip profile and integral curtain tracks and hooks for compartments without doors.
         1) Bobrick vinyl curtains.
         2) Stile Height: 83 inches.

D. Materials: Solidly fused plastic laminate with matte-finish melamine surfaces; integrally bonded colored face sheets and black phenolic-resin core.

E. Edges: Black; brown edges not acceptable.

F. Color:
   1. As selected by Architect from manufacturer's standard DuraLineSeries Compact Grade Laminate color range.
   2. As indicated on Drawings.
   3. Other color as selected by architect based on Manufacturer’s range and confirmed by local Manufacturer Representative.

G. Fire Resistance:
   1. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class B / Uniform Building Code: Class II.
      a. Flame Spread Index (ASTM E 84): 30 for panels and stiles.
      b. Smoke Developed Index (ASTM E 84): 55 for panels, 20 for stiles.
   2. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class A / Uniform Building Code: Class I.
      a. Flame Spread Index (ASTM E 84): 15-25 for panels, stiles and doors.
      b. Smoke Developed Index (ASTM E 84): 25 - 105 for panels, 20-90 for stiles.

H. Finished Thickness:
   1. Stiles and Doors: 3/4 inch

2. Panels and Screens: 1/2 inch.

I. Stiles: Floor-anchored stiles furnished with expansion shields and threaded rods.
   1. Leveling Devices: 7 gauge, 3/16 inches thick, corrosion-resistant, chromate- treated, double zinc-plated steel angle leveling bar bolted to stile; furnished with 3/8 inch diameter threaded rods, hex nuts, lock washers, flat washers, spacer sleeves, expansion anchors, and shoe retainers.
   2. Stile Shoes: One-piece, 22 gauge , 18-8, Type 304 stainless steel, 4 inch height; tops with 90 degree return to stile. One-piece shoe capable of adapting to 3/4 inch or 1 inch stile thickness and capable of being fastened (by clip) to stiles starting at wall line.

J. Wall Posts: Pre-drilled for door hardware, 18-8, Type 304, 16 gauge stainless steel with satin finish; 1 inch (25 mm) x 1-1/2 inches x 58 inches high.

K. Anchors: Expansion shields and threaded rods at floor connections as applicable. Threaded rods secured to supports above ceiling as applicable. Supports above ceiling furnished and installed as Work of Section 05 50 00 - Metal Fabrications.

L. Hardware:
   1. Compliance: Operating force of less than 5 lbs.
   2. Emergency Access: Hinges, latch allow door to be lifted over keeper from outside compartment on inswing doors.
   3. Materials: 18-8, Type 304, heavy-gauge stainless steel with satin finish.
   4. Doorstops: Prevents inswinging doors from swinging out beyond stile; on outswing doors, doorstop prevents door from swinging in beyond stile.
   5. Fastening: Hardware is secured to door and stile with pin-in-head Torx stainless steel machine screws. Hinges, latch and optional door stops secured to door with pin-in- head Torx stainless steel machine screws into factory-installed, threaded brass inserts. Fasteners for hinges latch and optional door stops secured directly into core not acceptable.
      a. Threaded Brass Inserts: Factory-installed; withstand direct pull force exceeding 1500 lbs. per insert.
   6. Clothes Hooks: Projecting no more than 1-1/8 inch from face of door.
   7. Door Latch: Track of door latch prevents inswing doors from swinging out beyond stile; on outswing doors, door keeper prevents door from swinging in beyond stile; 16 gauge sliding door latch, 14 gauge keeper.
   8. Locking: Door locked from inside by sliding door latch into keeper.
   9. Hinge Type:
      a. Standard.
         1) Balanced, with field-adjustable cam to permit door to be fully closed or partially open when compartment is unoccupied.
      b. Full-Height Institutional Hinge.
         1) Hinges: 16 gauge stainless steel, self-closing, 3 section hinges.
   10. Mounting Brackets:
       a. Standard concealed.
          1) Mounting Brackets: Mounted inside compartment; exposed brackets on exterior of compartment not acceptable with the exception of outswing doors.

- b. Full-Height.
  - 1) Mounting Brackets: 18 gauge stainless steel and extend full height of panel.
  - 2) U-Channels: Secure panels to stiles.
  - 3) Angle Brackets: Secure stiles-to-walls and panels to walls.

2.4 HIGH-PRESSURE LAMINATE WITH PARTICLE BOARD SUBSTRATE

A. High-Pressure Laminate Toilet Partitions:

- 1. Design Type:
  - a. Standard Height.
    - 1) Door/Panel Height: 58 inches.
    - 2) Floor Clearance: 12 inches.
  - b. Maximum Height.
    - 1) Door/Panel Height: 71-3/4 inches.
    - 2) Floor Clearance: 4-1/2 inches.
- 2. Mounting Configuration:
  - a. Floor-mounted.
    - 1) Stile Standard Height: 69 inches
    - 2) Maximum Height: 75-3/16 inches.
  - b. Floor-mounted, overhead-braced with extruded anodized aluminum headrails, 0.065 inch thick with anti-grip profile.
    - 1) Stile Height: 83 inches.
  - c. Floor-to-ceiling.
    - 1) Stile Standard Height: As required, 10 feet 0 inches maximum
  - d. Ceiling-hung.
    - 1) Stile Height: 8 feet 0 inches or as required 10 feet 0 inches maximum.

B. High-Pressure Laminate Urinal Screens:

- 1. Mounting Configuration:
  - a. Floor-to-ceiling.
    - 1) Screen Height: 58 inches with floor clearance: 12 inches.
    - 2) Stile Height: As required up to 10 feet 0 inches maximum.
  - b. Floor-to-ceiling maximum privacy.
    - 1) Screen Height: 71-3/4 inches with floor clearance: 4-1/2 inches.
    - 2) Stile Height: As required up to 10 feet 0 inches maximum.
  - c. Post-to-ceiling.
    - 1) Screen Height: 58 inches.
    - 2) Floor Clearance: 12 inches.
    - 3) Post Height: Up to 10 feet 0 inches maximum.
  - d. Post-to-ceiling maximum privacy.
    - 1) Screen Height: 71-3/4 inches.
    - 2) Floor Clearance: 4-1/2 inches.
    - 3) Post Height: Up to 10 feet 0 inches maximum.
  - e. Floor-anchored standard height.
    - 1) Screen Standard Height: 58 inches with floor clearance: 12 inches
    - 2) Stile Standard Height: 69 inches

- f. Floor-anchored maximum height.
  - 1) Screen Standard Height: 71-3/4 inches with floor clearance: 4- 1/2 inches
  - 2) Stile Maximum Height: 75-3/16 inches
- g. Wall-hung.
  - 1) Screen Height: 42 inches with 18 inches floor clearance.
  - 2) Screen Height: 48 inches with 12 inches floor clearance.

C. High-Pressure Laminate Dressing Compartments:
- 1. Design Type:
  - a. Standard Height.
    - 1) Door/Panel Height: 58 inches .
    - 2) Floor Clearance: 12 inches .
  - b. Maximum Height.
    - 1) Door/Panel Height: 71-3/4 inches.
    - 2) Floor Clearance: 4-1/2 inches.
- 2. Mounting Configuration:
  - a. Floor-mounted, overhead-braced with extruded anodized aluminum headrails, 0.065 inch thick with anti-grip profile and integral curtain tracks and hooks for compartments without doors.
    - 1) Bobrick vinyl curtains.
    - 2) Stile Height: 83 inches.

D. Finished Thickness: 1 inch for stiles, doors, screens and panels.

E. Materials: 3-ply, stiles, panels, doors, and screens.
- 1. Cores: 45 lb density, industrial grade, resin-impregnated, particle board.
- 2. Surfaces: High-pressure laminated plastic NEMA LDS-1985 minimum thickness 0.050 inch with matte finish.
- 3. Fabrication: Bonded high-pressure plastic laminate to core material with adhesive specially formulated to prevent delamination. Edges bonded prior to bonding face sheets. Splices or joints in faces or edges are not acceptable except in the case of laminate material limitations.
- 4. Color:
  - a. As selected by Architect from manufacturer's standard High Pressure Laminate range.
  - b. As indicated on Drawings.
  - c. As selected by Architect from manufacturer's 10 Day Rapid Response DesignerSeries range.

F. Fire Resistance:
- 1. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class B / Uniform Building Code: Class II.
  - a. Flame Spread Index (ASTM E 84): 60 for panels and stiles.
  - b. Smoke Developed Index (ASTM E 84): 265 for panels and stiles.

G. Stiles: Floor-anchored stiles furnished with expansion shields and threaded rods.

1. Leveling Devices: 3/8 inch x 7/8 inch steel bar welded to 11 gauge steel-reinforcing core; chromate-treated and double zinc-plated; welded to sheet-steel core of stiles.
2. Stile Shoes: One-piece, 22 gauge, 18-8, Type 304 stainless steel, 4 inch height; tops with 90 degree return to stile. One-piece shoe capable of adapting to 3/4 inch or 1 inch stile thickness and capable of being fastened (by clip) to stiles starting at wall line.

H. Wall Posts: Pre-drilled for door hardware, 18-8, Type 304, 16 gauge stainless steel with satin finish; 1 inch x 1-1/2 inches x 58 inches high.

I. Anchors: Expansion shields and threaded rods at floor connections as applicable. Threaded rods secured to supports above ceiling as applicable. Supports above ceiling furnished and installed as Work of Section 05 50 00 - Metal Fabrications.

J. Hardware:
1. Compliance: Operating force of less than 5 lbs.
2. Emergency Access: Hinges, latch allow door to be lifted over keeper from outside compartment on inswing doors.
3. Materials: Stainless Steel 18-8, Type 304, heavy-gauge stainless steel with satin finish.
4. Fastening: Hardware secured to door and stile by theft-resistant, pin-in-head Torx stainless steel machine screws into factory-installed, threaded inserts.
5. Door Latch: Track of door latch prevents inswing doors from swinging out beyond stile; on outswing doors, door keeper prevents door from swinging in beyond stile; 16 gauge sliding door latch, 14 gauge keeper.
6. Locking: Door locked from inside by sliding door latch into keeper.
7. Hinge Type:
    a. Standard.
        1) Balanced, with field-adjustable cam to permit door to be fully closed or partially open when compartment is unoccupied.
    b. Full-Height Institutional Hinge.
        1) Hinges: 16 gauge stainless steel, self-closing, 3 section hinges.
8. Mounting Brackets:
    a. Standard Concealed.
        1) Mounting Brackets: Mounted inside compartment; exposed brackets on exterior of compartment not acceptable with the exception of outswing doors.
    b. Full-Height.
        1) Mounting Brackets: 18 gauge stainless steel and extend full height of panel.
        2) U-Channels: Secure panels to stiles.
        3) Angle Brackets: Secure stiles-to-walls and panels to walls.

2.5 HIGH-PRESSURE LAMINATE WITH PARTICLE BOARD SUBSTRATE

A. High Pressure Laminate Toilet Partitions:
1. Design:
    a. Standard Height.
        1) Door/Panel Height: 58 inches .

            2) Floor Clearance: 12 inches.
    2. Mounting Configuration:
        a. Floor-mounted.
            1) Stile Height: 69 inches .
        b. Floor-mounted, overhead-braced with extruded anodized aluminum headrails, 0.065 inch thick with anti-grip profile.
            1) Stile Height: 83 inches.
        c. Ceiling-hung.
            1) Stile Height:8 feet 0 inches or as required 10 feet 0 inches maximum.

B. High Pressure Laminate Urinal Screens:
    1. Mounting Configuration:
        a. Floor-to-ceiling.
            1) Screen Height: 58 inches with floor clearance: 12 inches.
        b. Post-to-ceiling.
            1) Screen Height: 58 inches.
            2) Floor Clearance: 12 inches.
            3) Post Height: Up to 10 feet 0 inches maximum.
        c. Wall-hung.
            1) Screen Height: 42 inches with 18 inches floor clearance.
            2) Screen Height: 48 inches with 12 inches floor clearance.

C. High Pressure Laminate Dressing Compartments:
    1. Design Type:
        a. Standard Height.
            1) Door/Panel Height: 58 inches.
            2) Floor Clearance: 12 inches .
    2. Mounting Configuration:
        a. Floor-mounted, overhead-braced with extruded anodized aluminum headrails, 0.065 inch thick with anti-grip profile and integral curtain tracks and hooks for compartments without doors.
            1) Bobrick vinyl curtains.
            2) Stile Height: 83 inches.

D. Finished Thickness: 1 inch for stiles, doors, screens and panels.

E. Materials: 3-ply, stiles, panels, doors, and screens.
    1. Cores: 45 lb density, industrial grade, resin-impregnated, particle board.
    2. Surfaces: High-pressure laminated plastic NEMA LDS-1985 minimum thickness 0.050 inch with matte finish.
    3. Fabrication: Bonded high-pressure plastic laminate to core material with adhesive specially formulated to prevent delamination. Edges bonded prior to bonding face sheets. Splices or joints in faces or edges are not acceptable except in the case of laminate material limitations.
    4. Color:
        a. As selected by Architect from manufacturer's standard Plastic Laminate range.
        b. As indicated on Drawings.

    c. As selected by Architect from manufacturer's 5 Day Rapid Response MetroSeries range.

F. Fire Resistance:
  1. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class B / Uniform Building Code: Class II.
    a. Flame Spread Index (ASTM E 84): 60 for panels and stiles.
    b. Smoke Developed Index (ASTM E 84): 265 for panels and stiles.

G. Stiles: Floor-anchored stiles furnished with expansion shields and threaded rods
  1. Stile Leveling Device:
    a. Standard:
      1) Overhead-Braced: 12 gauge, 3 inches x 1-1/4 inches plated steel stile bracket factory installed to bottom of stile. Furnished with leveling bolt, shoe retainer, floor L-bracket, plastic anchor #14-16, #14 x 5/8 inches stainless steel sheet-metal screws and #14 x 1-3/4 inches stainless steel sheet- metal floor screws.
      2) Floor-Anchored: 3/8 inches x 1 inches steel bar, zinc- chromate plated, bolted to stile using 6 inches x 3/8 inches diameter carbon steel lag bolt. Furnished with 3/8 inches diameter threaded rods, hex nuts, washers, spacer sleeve (ceiling-hung only), expansion shield and shoe retainer.
      3) Ceiling-Hung: 3/8 inches x 1 inches steel bar, zinc- chromate plated, bolted to stile using 6 inches x 3/8 inches diameter carbon steel lag bolt. Furnished with 3/8 inches diameter threaded rods, hex nuts, washers, spacer sleeve (ceiling-hung only), expansion shield and shoe retainer.
    b. Steel Core Stile Option:
      1) Leveling Devices: 3/8 inch x 7/8 inch steel bar welded to 11 gauge steel-reinforcing core; chromate-treated and double zinc-plated; welded to sheet-steel core of stiles.
  2. Stile Shoes: One-piece, 22 gauge, 18-8, Type 304 stainless steel, 4 inch height; tops with 90 degree return to stile. One-piece shoe capable of adapting to 3/4 inch or 1 inch stile thickness and capable of being fastened (by clip) to stiles starting at wall line.

H. Wall Posts: Pre-drilled for door hardware, 18-8, Type 304, 16 gauge stainless steel with satin finish; 1 inch x 1-1/2 inches x 58 inches high

I. Anchors: Expansion shields and threaded rods at floor connections as applicable. Threaded rods secured to supports above ceiling as applicable. Supports above ceiling furnished and installed as Work of Section 05 50 00 - Metal Fabrications.

J. Hardware:
  1. Compliance: Operating force of less than 5 lbs.
  2. Emergency Access: Hinges, latch allow door to be lifted over keeper from outside compartment on inswing doors.
  3. Materials:
    a. Stainless Steel
      1) Hinges: Pivot hinges constructed of stainless steel with satin finish.

2) Door Hardware: Latches, keepers, coat hooks constructed of stainless steel with satin finish.
3) Mounting Brackets: Constructed of 18-8, Type-304, heavy-gauge stainless steel with satin finish.

PART 3 - PRODUCTS

3.1 PREPARATION

A. Prepare substrates including but not limited to blocking and supports in walls and ceilings at points of attachment using methods recommended by the manufacturer for achieving the best result for the substrates under the project conditions.
   1. Inspect areas scheduled to receive compartments for correct dimensions, plumbness of walls, and soundness of surfaces that would affect installation of mounting brackets.
   2. Verify spacing of plumbing fixtures to assure compatibility with installation of compartments.

B. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

C. Do not proceed with installation until substrates have been properly prepared with blocking and supports in walls and ceilings at points of attachment and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.

3.2 INSTALLATION

A. Install products in strict compliance with manufacturer's written instructions and recommendations, including the following:
   1. Verify blocking and supports in walls and ceilings has been installed properly at points of attachment.
   2. Verify location does not interfere with door swings or use of fixtures.
   3. Use fasteners and anchors suitable for substrate and project conditions
   4. Install units rigid, straight, plumb, and level.
   5. Conceal evidence of drilling, cutting, and fitting to room finish.
   6. Test for proper operation.

3.3 ADJUSTING, CLEANING AND PROTECTION

A. Adjust hardware for proper operation after installation. Set hinge cam on in-swinging doors to hold doors open when unlatched. Set hinge cam on out-swinging doors to hold unlatched doors in closed position.

B. Touch-up, repair or replace damaged products.

C. Clean exposed surfaces of compartments, hardware, and fittings.

END OF SECTION 10 21 13

SECTION 10 26 00 – WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm (material producer) with not less than two years of production experience, whose published literature clearly indicates general compliance of products with requirements of this section.

1.01.1.1.3 Installer Qualifications: Firm specializing in installation of wall protection systems with not less than one year experience in installations similar to that required for this Project.

B. Single Source Responsibility: Provide material produced by a single manufacturer for each wall and corner guard type.

1.4 SUBMITTALS

A. Product Data:

1. Product data for each wall surface protection system component and installation accessory required, including installation methods for each type of substrate. Provide written data on each required component including physical characteristics, such as durability, resistance to fading, and flame resistance. Prepare a sample for review and approval by UT Health from the same material to be used for the Work.

B. Shop Drawings: Showing locations, extent, and installation details of wall and corner guards, and other protection systems. Show methods of attachment to adjoining construction.

1.5 DELIVERY, STORAGE and HANDLING

A. Deliver materials to the Project Site in original factory wrappings and containers, clearly labeled with identification of manufacturer, brand name, quality or grade, fire hazard classification, and lot number. Store materials in original undamaged packages and containers, inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity; laid flat, blocked off ground to prevent sagging and warping.

1.01.1.1.4 Comply with instructions and recommendations of manufacturer for special delivery, storage, and handling requirements.

1.6 SEQUENCING AND SCHEDULING

A. Sequence wall and corner guard and wall and door protection system installation with other Work to minimize possibility of damage and soiling during remainder of construction period.

1.7 MAINTENANCE

A. Maintenance Instructions: Submit manufacturer's printed instructions for maintenance of installed Work, including methods and frequency recommended for maintaining optimum condition under anticipated traffic and use conditions. Include precautions against materials and methods which may be detrimental to finishes and performance.

1.01.1.1.5 Replacement Materials: After completion of Work, deliver not less than 2 percent of each type, color, and pattern of wall and corner guard, and wall protection material exclusive of material required to properly complete installation. Furnish accessory components as required. Furnish replacement materials from same production run as materials installed. Package replacement materials with protective covering, identified with appropriate labels.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

1. Wall and corner guards to be by INPRO, World Headquarters, S80 W18766 Apollo Drive, Muskego, WI 53150, 800.222.5556

1. 2. Or Approved Equal

2.3 MATERIALS

A. Provide wall and corner guards in materials as indicated. Fabricate units with tight seams and joints, with exposed edges rolled. Provide units with surfaces free or evidence of wrinkling, chipping, uneven coloration, dents and other imperfections.

1. Stainless Steel: Minimum 16 gage, Type 430, #4 satin finish.
2. High Impact Vinyl/Acrylic Alloy: Minimum .078" thick, Class A Fire Rating, chemical and stain resistant. Provide material with ability to resist, without damage, a blow of 30 ft. lbs. per sq. in. at 60 degrees F.

B. Wall and Corner Guards: Provide wall and corner guards in dimensions, mounting, and profile details as indicated in configuration as shown on drawings. Provide material in 90 degree corners unless otherwise indicated, mounting holes 8 inches on center and formed edges.

1.01.1.1.6 Wall Protection System: Provide crash rails, bumper guards, chair wheel rub rails, and handrails as indicated on drawings and in schedules. Provide system of wall protection in consistent materials, mounted at specified heights.

1. D. Crash Rails: Provide crash rails designed to absorb shock without damage to adjacent wall in dimensions and finishes indicated.

2.4 FINISHES

A. Provide materials in colors as selected by Architect from manufacturer's standard colors and patterns.

1.01.1.1.7 Provide materials in colors as specified by Architect for custom color.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions in which wall and corner guards and wall protection systems will be installed. Do not proceed until unsatisfactory conditions have been corrected.

1.01.1.1.8 Prior to installation of wall and corner guards, clean substrate to remove dust, debris, and loose particles.

B. Ascertain that substrate is free of previous surface applied material. Prepare substrate surface to accept new material.

1.01.1.1.9 Illuminate areas of installation using building's permanent lighting system; temporary lighting alone will not be acceptable.

C. Verify that materials are those specified before installing.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.10 All installation shall be in accordance with manufacturer’s published recommendations.

B. Install surface mounted wall and corner guards and wall and door protection systems and accessories after other finishing operations, including painting, have been completed.

1.01.1.1.11 Do not use material with chips, cracks, voids, stains, or other defects which might be visible in the finished Work.

C. Install material and assemblies to comply with drawings and final shop drawings in strict compliance with manufacturer's printed instructions. Adjust accessories for proper system alignment.

3.3 FIELD QUALITY CONTROL

A. Remove and replace material which is broken, chipped, stained or otherwise damaged and which does not match adjoining Work. Provide new matching units, installed as specified and in manner to eliminate evidence of replacement.

3.4 CLEANING

A. Immediately upon completion of installation, clean installed material.

1.01.1.1.12 Remove excess adhesive, using methods and materials recommended by manufacturer.

B. Remove surplus materials, rubbish, and debris resulting from installation upon completion of Work, and leave areas of installation in neat, clean condition.

END OF SECTION 10 26 00

SECTION 10 28 13 - TOILET ACCESSORIES - COMMERCIAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Inserts and Anchorages: Furnish accessory manufacturers' standard inserts and anchoring devices that must be set in concrete or built into masonry. Coordinate delivery with other Work to avoid delay.

1.01.1.1.3 Single Source Responsibility: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise acceptable to Architect.

1.4 SUBMITTALS

A. Product Data:

1. Submit a complete listing of all manufacturers, products, model numbers, and designs proposed for use in the Work of this Section.

B. Record Documents:

1. Maintain two copies of all shop drawings, product data, and samples, manufacturer's specifications, recommendations, installation instructions, and maintenance data at the Project Site. At Project Closeout, turn over both copies to the Architect who will transmit one copy to UT Health.

1.01.1.1.3.1 PROJECT CONDITIONS

C. Coordination: Coordinate accessory locations, installation, and sequencing with other Work to avoid interference with and ensure proper installation, operation, adjustment, cleaning, and servicing of toilet accessory items.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. Product numbers scheduled below are products of the **Bobrick Washroom Equipment, Inc**. Subject to compliance with requirements, other manufacturers offering toilet accessories that may be incorporated in the Work include, but are not limited to, the following:

1. Or Approved Equal

1.01.1.1.3.2 Accessory schedule

B. Provide the following accessories at locations indicated.

  1. Paper Towel Dispenser

    a. To be provide by UT Health Housekeeping Department

    1.01.1.1.3.2.1 Soap Dispenser

    b. To be provide by UT Health Housekeeping Department

    c. Mirrors with Stainless Steel Frame

    1.01.1.1.3.2.2 Mirrors with Stainless Steel Frame and Shelf

    d. Manufactured by Bobrick or equal

    1.01.1.1.3.2.3 Toilet Tissue Dispenser

    e. Bobrick B-2888 (Surfaced-Mounted)

    1.01.1.1.3.2.4 Hook Strip

    f. B-232 x 24 inch

    1.01.1.1.3.2.5 Mop and Broom Holder

    g. B-224 x 36 inch (with shelf and rag hooks)

    1.01.1.1.3.2.6 Folding Shower Seat

    h. B-517/518

    1.01.1.1.3.2.7 Grab Bars

    i. B-5806 Series x lengths indicated

C. Provide the following accessories at locations indicated. All product numbers listed are by the Bobrick Company unless otherwise indicated.

  1. Toilet Tissue Dispensers:

    a. Recessed Double Holder; Bradley 5412

    b. Large (Jumbo Roll) Holder; B-2892

    c. Recessed Toilet Seat Cover Dispenser; B-301

    d. Wall Mounted; ASI 5001-SS

    1.01.1.1.3.2.8 Grab Bars:

    e. Bobrick Horizontal; B5805 X 12 inch

    f. Bobrick Horizontal; B5805 X 24 inch

    g. Bobrick Horizontal; B5805 X 36 inch

    h. Bobrick Horizontal; B5805 X 42 inch

    i. Bobrick Horizontal; B5805 X 48 inch

    1.01.1.1.3.2.9 Shower Accessories:

    j. Type 63: Robe Hook (Wall Mounted); B-2116

k. Type 64: Robe Hook and Bumper (Toilet Partition Mounted); B-212. To be provided under the Work of the Toilet Partition section.

l. Clothes Hook; B-233

m. Folding Handicapped Shower Bench (Right Hand); Bobrick B-517

n. Folding Handicapped Shower Bench (Left Hand); Bobrick B-518

1.01.1.1.3.2.10 Mirrors:
o. Framed (18 inch x 36 inch); B-165-1836

p. Framed (24 inch x 60 inch); B-165-2460

q. W/Stainless Steel Channel & Frame: B-166 Series

1) 18 inch X 36 inch; B166-1836

2. Miscellaneous Accessories:

a. Mop and Broom Holder (24 inch Long); Bradley B223 x 24 inch

b. Folding Utility Shelf; B-287

c. Baby Changing Station; Bobrick Koala Kare KB100-00

d. Hat and Coat Rack; Raymond Engineering "Rigid Rak" #354 Series.

e. Shelf; B-295 x 24 inch

f. Shelf; B-295 x 60 inch

2.3 MATERIALS, GENERAL

A. Stainless Steel: AISI Type 302/304, with polished No. 4 finish, 0.034 inch (22 gage) minimum thickness.

1.01.1.1.4 Brass: Leaded and unleaded, flat products, ASTM B 19; rods, shapes, forgings, and flat products with finished edges, ASTM B 16; Castings, ASTM B 30.
B. Sheet Steel: Cold rolled, commercial quality ASTM A 366, 0.04 inch (20 gage) minimum. Surface preparation and metal pretreatment as required for applied finish.

1.01.1.1.5 Galvanized Steel Sheet: ASTM A 527, G60.
C. Chromium Plating: Nickel and chromium electro deposited on base metal, ASTM B 456, Type SC 2.

1.01.1.1.6 Baked Enamel Finish: Factory applied, gloss white, baked acrylic enamel coating.
D. Stainless Steel Mirror Surfaces: Not less than 0.04 inch (20 gage) AISI Type 302/304 stainless steel sheet, stretcher leveled with No. 8 polished mirror finish. Bond to 1/4 inch minimum hardboard backing.

1.01.1.1.7 Galvanized Steel Mounting Devices: ASTM A 153, hot dip galvanized after fabrication.
E. Fasteners: Screws, bolts, and other devices of same material as accessory unit, or of galvanized steel where concealed.

2.4 MISCELLANEOUS ACCESSORIES

A. Mop and Broom Holder/Utility Shelf: Combination unit with 0.05 inch (18 gage), Type 304, stainless steel shelf with 1/2 inch returns, 0.062 inch (16 gage) support brackets for wall mounting. Provide 0.062 inch (16 gage) stainless steel hooks for wiping rags on front of shelf, together with spring loaded, rubber hat, cam type mop/broom holders; 1/4 inch diameter stainless steel drying rod suspended beneath shelf. Provide unit 36 inches long and complete with four mop/broom holders and three hooks.

1.01.1.1.8 Mop and Broom Holder: 0.05 inch (18 gage), Type 304, stainless steel hat channel with spring loaded, rubber, cam type mop/broom holders. Provide unit 36 inches long and complete with four holders.

B. Double Prong Robe Hook: Heavy duty satin finished stainless steel double prong robe hook; rectangular wall bracket with backplate for concealed mounting.

1.01.1.1.9 Diaper Changing Station: Mildew resistant, molded polyethylene body, engineered to support a minimum of 150 lb static weight when opened, with built in dispenser of sanitary liners.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to requirements, provide one of the following:

   a. Diaper Deck, American Infant Care Products.

   b. Koala Bear Care, J.B.J. Industries, Inc.

2.5 FABRICATION

A. No names or labels are permitted on exposed faces of toilet and bath accessory units. On either interior surface not exposed to view or on back surface, provide identification of each accessory item either by a printed, waterproof label or a stamped nameplate indicating manufacturer's name and product model number.

1.01.1.1.10 Surface Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.

B. Keys: Provide universal keys for access to toilet accessory units requiring internal access for servicing, re-supply, etc. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction, including the most current Texas Accessibility Standards regulations.

1.01.1.1.11 All installation shall be in accordance with manufacturer’s published recommendations.

B. Install toilet accessory units according to manufacturers' instructions, using fasteners appropriate to substrate as recommended by unit manufacturer. Install units plumb and level, firmly anchored in locations and at heights indicated.

1.01.1.1.12 Install grab bars to withstand a downward load of at least 250 lbf, complying with ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.

1.01.1.1.13 Clean and polish all exposed surfaces strictly according to manufacturer's recommendations after removing temporary labels and protective coatings.

END OF SECTION 10 28 13 13

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SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain extinguishers and cabinets from one source from a single manufacturer.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Standard for Portable Fire Extinguishers."

C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1.4 SUBMITTALS

A. Product Data:

1. Product data for each type of product specified.

2. For fire extinguisher cabinets include rough-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type and materials, trim style, door construction, panel style, and materials.

1.01.1.1.1.1 Samples:

3. Samples for initial selection purposes in form of manufacturer's color charts showing full range of colors available for those units with factory-applied color finishes.

4. Samples for verification purposes of each type of metal finish required, prepared on metal samples of same thickness and alloy indicated for final unit of Work.

    a. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 FIRE EXTINGUISHERS

A. Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by Architect from manufacturer's standard, that comply with authorities having jurisdiction.

B. Provide fire extinguisher types as follows using fire extinguisher schedule on Drawings:

1. Multi-Purpose Dry Chemical Type: UL Rated 2A-10BC, 5 lb. nominal capacity, in enameled steel container, for Class A, B, and C fires (Use requires special approval by M. D. Anderson Environmental Health and Safety).

    a. Badger Model B5M-1/B5M1-B

    b. Or approved equal

2. Multi-Purpose Dry Chemical Type: UL Rated 4A-60BC, 10 lb. nominal capacity, in enameled steel container, for Class A, B, and C fires (Use requires special approval by M. D. Anderson Environmental Health and Safety).

    a. Badger Model B10M/B10M-1

    b. Or approved equal

3. Stored-Pressurized Water Type: UL rated 2A, 2-1/2 gallons nominal capacity, in a stainless steel container for Class A fires.

    a. Badger Model WP-61

    b. Or approved equal

4. Stored-Pressure Wet Chemical Type: UL-rated 2AK, **Must meet NFPA requirements for kitchen occupancy,** 6-liters nominal capacity, in stainless steel container with pressure-indicating gauge.

    a. Badger Model WC100

    b. Or approved equal

5. Carbon Dioxide Type: UL rated 5 BC, 5 lb nominal capacity, in manufacturer's standard enameled metal container.

    a. Badger Model B5V

    b. Or approved equal

6. Carbon Dioxide Type: UL rated 10 BC, 10 lb nominal capacity, in manufacturer's standard enameled metal container.

    a. Badger Model B10V

    b. Or approved equal

  7. Carbon Dioxide Type: UL rated 15BC, 15 lb nominal capacity, in manufacturer's standard enameled metal container

    a. Amerex Model 331

    b. Ansul Model CD15-1

    c. Badger Model B15V

  8. Halotron Type: UL rated 2A:10 BC, 15 1/2 lb nominal capacity, in enameled steel container with pressure indicating gauge.

    a. Badger Model 5 HB

    b. Or approved equal

C. Extinguisher Drawing Schedule: Provide the following fire extinguishers, brackets, and cabinets at locations indicated:

  1. Type FE-1: Bracket mounted 2A-10BC dry chemical.

  2. Type FE-2: In- cabinet 2A-10BC dry chemical.

  3. Type FE-3: Bracket mounted 2A Stored-Pressurized water extinguisher.

  4. Type FE-4: In-cabinet 2A Stored-Pressurized water extinguisher.

  5. Type FE-5: Bracket mounted 2AK 6-lites Stored-Pressurized Wet Chemical extinguisher.

  6. Type FE-6: Bracket mounted 5-BC Carbon Dioxide extinguisher.

  7. Type FE-7: In-cabinet 5-BC Carbon Dioxide extinguisher.

  8. Type FE-8: Bracket mounted 10-BC Carbon Dioxide extinguisher.

  9. Type FE-9: In-cabinet 10-BC Carbon Dioxide extinguisher.

  10. Type FE-10: Bracket mounted 15-BC Carbon Dioxide extinguisher.

  11. Type FE-11: In-cabinet 15-BC Carbon Dioxide extinguisher.

  12. Type FE-12: Bracket mounted 5-BC Halotron extinguisher.

  13. Type FE-13: In-cabinet 5-BC Halotron extinguisher.

  14. Type FE-14: Bracket mounted 2A-10BC Halotron extinguisher.

  15. Type FE-15: In-cabinet 2A-10BC Halotron extinguisher.

  16. Type FE-16: Cabinet mounted 5BC Carbon Dioxide installed side by side with a 2A Stored-Pressurized water extinguisher.

2.3 mounting brackets

A. Brackets: Designed to prevent accidentally dislodging extinguisher, of sizes required for type and capacity of extinguisher indicated.

1. Provide manufacturer’s standard metal brackets for extinguishers not located in cabinets.

2.4 FIRE EXTINGUISHER CABINETS

A. Provide fire extinguisher cabinets where indicated and from the same manufacturer as the extinguishers. Provide sizes required for housing specified fire extinguishers, and as follows:

B. Construction: Manufacturer's standard enameled steel box, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind smooth. Miter and weld perimeter door frames.

C. Fire Rated Cabinets: UL listed with UL Listing Mark with rating of wall where it is installed.

D. Cabinet Type: Suitable for mounting conditions indicated of the following types:

1. Recessed: Cabinet box (tub) fully recessed in walls of sufficient depth to suit style of trim indicated.

   a. Larsen’s Architectural Series 2720-R and FS 2720-R or approved equal

2. Semi-recessed: Cabinet box (tub) partially recessed in walls of shallow depth.

   a. Fire rated - Larsen’s Architectural Series 2720-RL (2-½” Trim Style) and FS 2720-RL or approved equal.

   b. Fire rated - Larsen’s Architectural Series 2720-RM (4-½” Trim Style) and FS 2720-RM or approved equal.

E. Trim Style: Fabricate trim in one piece with corners mitered, welded, and ground smooth.

1. Trimless with hidden flange of same metal and finish as box (tub) that overlaps surrounding wall finish and is concealed from view by an overlapping door.

2. Exposed Trim: One piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

   a. Square edge trim with 1/4 to 5/16 inch backbend depth.

   b. Rolled edge trim with 1-1/4 inch backbend depth.

   c. Rolled edge trim with 2-1/2 inch backbend depth.

   d. Rolled edge trim with 4-1/2 inch backbend depth.

   e. Trim Metal: Of same metal and finish as door.

   f. Trim Metal: Enameled steel.

F. Door Material and Construction: Manufacturer's standard door construction, of material indicated, coordinated with cabinet types and trim styles selected.

1. Cold-Rolled Steel: Metal finsih

1.01.1.1.1.2 Identify fire extinguisher in cabinet with FIRE EXTINGUISHER lettering applied to door vertically. Provide lettering to comply with authorities having jurisdiction for letter style, red in color, size, spacing, and location.

G. Identify bracket mounted extinguishers with FIRE EXTINGUISHER in red letter decals applied to wall surface. Use letter size, style, and location as selected by Architect.

H. Door Style: Manufacturer's standard design.

    1. Solid Panel: Full flush opaque panel of material indicated.

1.01.1.1.1.3 Door Hardware:

    2. Provide manufacturer's standard door operating hardware of proper type for cabinet type, trim style, and door material and style indicated. Provide concealed or continuous type hinge permitting door to open 180 deg.

    3. Special Requirement: Provide recessed concealed handle with cam action latch.

2.5 FINISHES FOR FIRE EXTINGUISHER CABINETS, GENERAL

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering prior to shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install in locations and at mounting heights indicated or, if not indicated, at heights to comply with applicable regulations of governing authorities.

    1. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.

    2. Fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb.

END OF SECTION 10 44 00 00

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SECTION 10 81 00 – PEST CONTROL

PART 1 - FOUNDATIONS AND SLABS

A. Drainage Design

1. Provide a ¼” slope at patio slabs, sidewalks, and driveways away from the building.

2. Tamp backfill to prevent settling and slope final grade away from the foundation at a rate of ½” per foot over a minimum distance of 10 feet.

B. Reduce Moisture

1. Do not block foundation vents with shrubbery, mulch, or other landscaping materials. Maintain vent openings to crawl spaces.

2. Use a continuous, durable subgrade membrane sealed at all splices, perimeters, and protrusions in order to minimize foundation moisture problems. The membrane product selected should be specifically manufactured for use as a subgrade membrane and conform to ASTM E1745, latest edition, 0.1 perm maximum. Installation should conform to ASTM E1643, latest edition.

C. Prevent Pest Access

1. For any ground-level space (e.g. raised foundation crawl space) requiring foundation vents, specify corrosion-resistant vent material (e.g. bronze) and a vent opening size smaller than the pest to be inhibited. For example, for typical ants and termites, use #50 bronze mesh between layers of ½ to 1-inch mesh for durability. Building codes generally require mesh with maximum opening of 1/4 inch, which will block rodent access.

2. Foundation vents should be at least 150 mm (6 inches) above finished ground level.

3. For visual access the upper 100 mm (4 inches) of the edges of a slab should remain exposed at all times; it should not be concealed by masonry, timber, soil, paving, etc.

4. The vapor barrier underneath a slab should end no higher than the level of the finished soil or paving level. Slab formwork should include 100 mm (4 inches) of smooth faced timber around the top of the slab edge. The purpose of these construction details is to avoid indentations which allow undetected termite access.

D. Foundation Access

1. Provide 18" clearance beneath and 6" clearance between accessory structures and exterior wall coverings at decks, fences, patios, planters, and other accessory wood structures. If this clearance is not possible, construct accessory structures so that they are easily removable to allow inspection for termites.

2. Provide easily removable components to allow access to the foundation for inspections.

3. In order to minimize the entry of pests via joints, pour concrete patios as part of the main slabs.

B. Foundation and Slab Isolation

1. No cellulose-containing material (wood scraps, form boards, vegetation, stumps, large dead roots, cardboard, trash, and foreign material) should be buried on the construction site within fifty feet of any building, especially in areas with high termite pressure.

2. Fill material used around structures should be clean and free of vegetation and cellulose material.

3. Prior to concrete placement, clean all cellulose-containing material from cells and cavities in masonry units to inhibit termite colonization.

4. After all foundation work is completed, remove all loose wood and debris from the crawl space and within one foot of the perimeter of the building.

C. Termite Resistant Materials

1. Use steel posts for post and beam foundations, especially in areas with high termite pressure. The ends of the posts should be sealed at both ends with welded plates and the posts should be set in concrete foundations.

2. In areas of high termite hazard, avoid Exterior Insulation and Finish Systems (EIFS, commonly referred to as synthetic stucco).

3. In areas of high termite hazard, avoid subgrade foam insulation on the exterior of the foundation, or pre-formed closed cell foam foundation systems.

D. Foundation and Slab Joints

1. Minimize need for expansion joints when designing slabs. When expansion joints are used, inspection access should be readily available and the use of termite-resistant mesh should be considered. In one study, 83% of subterranean termites entering buildings came in through expansion joints in concrete slabs.

2. In order to minimize voids in concrete slabs, mechanically compact concrete with a vibrator when pouring a slab.

3. Cure concrete slabs slowly to reduce shrinkage and cracks. Moist curing periods should generally not be less than seven days. Consult a structural engineer for design standards.

4. Embed anchor bolts in slabs as the slab is poured. If additional anchors are necessary, use adhesive anchoring systems rather than expanding fasteners to avoid causing cracks.

5. For foundations and slabs up to about 50 feet in dimension, use liberal applications of topical curing compounds to decrease cracking.

6. For foundations about 50 to 100 feet in dimension, use adequate concrete reinforcing and proper concrete mix design, placement, finishing, and curing techniques. Additionally, use a shrinkage limiting concrete admixture.

7. Concrete slab foundations should be monolithic (floor slab integrated and poured simultaneously with footings). Unplanned construction joints should be minimized. In areas of high termite pressure, any joints should be protected with mesh barriers or sand (graded stone) barriers. Mesh barriers should be laid on top of the vapor barrier and have a 15 mm accordion fold under the joint. Edges should be turned up 25 mm to be cast into the slab. The accordion fold should be protected by a strip of vapor barrier material so that the concrete does not bond to the accordion fold. Alternatively, a mesh barrier with an accordion fold can be parged to the top of the slab. Sand barriers should be confined within a void adjoining the joint that is at least 75 mm deep and at least 50 mm wide. A retainer cast into the slab should be used to confine the sand particles.

E. Termite Shielding

1. When stainless steel mesh is used as a termite barrier, the mesh should be made from grade 304 or 316 wire with a minimum diameter of 0.18 mm. The maximum aperture size should be 0.66 mm x 0.45 mm. This maximum size should be reduced if local termite species are known to be small. As necessary the mesh should be parged to concrete foundations with a grout consisting of water-dispersed copolymer, Type GP Portland cement and sieved aggregate that can pass through the stainless steel mesh. The mesh should not contact dissimilar metals that will produce a corrosion reaction. If pieces of mesh need to be joined, the joint should consist of an area 10-15 mm wide where the edges of the two pieces are folded together 2 1/2 times or a parged area 35 mm wide where the pieces overlap. Mesh can be used as a perimeter barrier for masonry exterior walls when parged to the concrete slab, draped across the cavity, and then built into the exterior wall. It can also be used as a continuous barrier under concrete slabs, or as a barrier under joints and for utility penetrations.

2. If termite shields are used to reduce subterranean termite damage, they should be constructed of galvanized steel at least 0.5 mm thick; sheet copper at least 0.4 mm thick; stainless steel at least 0.4 mm thick; aluminum alloy at least 0.5 mm thick; copper and zinc alloys at least 0.5 mm thick; or woven stainless steel mesh. Joints and corners should be mitered and soldered, welded, or brazed. Shields should extend 70-80 mm past the foundation or foundation component. The last 30 mm of the shield should be bent downward at a 45 degree angle to reduce injuries during inspection. In addition, corners should be rounded The slippery metal of termite shields provides a poor footing for termites and their tubes, although there is controversy about their effectiveness. They are perhaps most valuable for increasing the ability of inspectors to spot signs of infestation. The shields should be constructed by qualified professionals, with no gaps for termite access, and in settings that permit inspection.

3. Where graded particles (sand or basalt) are used as a termite barrier, the particles should be graded and shaped so that a sufficient proportion of them are of a size that cannot be transported by local termite species. They also should be able to be placed so that voids between particles to not permit penetration of local termite species. They can be either igneous or metamorphic stone. The wet/dry analysis must have less than 35% variation and their specific gravity must be at least 2.52. Graded particles can be used as a perimeter barrier when installed in wall cavities or in a trench around the foundation. In either case the minimum depth of the particles should be 75 mm. Trenches should be at least 100 mm wide. Graded particles can also be used as a continuous under-slab barrier. These barriers should be 75-100 mmm deep and compacted with a vibrating plate-type tamper. Graded particles can also be used as a barrier under joints and around utility penetrations. Appropriate diameters for particles are 1.2-1.7 mm for the western subterranean termite, 1.7-2.8 mm for the eastern subterranean termite, and 1.7-2.4 mm for the Formosan termite.

F. Utility Penetration of Foundations and Slabs

1. Use epoxy immediately prior to pouring a slab to seal concrete around utilities.

2. Mesh barriers should consist of a flange of mesh 50 mm wide. The mesh flange should be attached to the penetrating utility with a stainless steel clamp and embedded in the slab. Alternatively, the mesh flange can be attached with a stainless steel clamp and then parged to the top surface of the slab.

3. For sand barriers, concrete should be poured in a circular area 25 mm around the utility pipe. That void should then be filled with sand at least 75 mm deep. See 1.9.3 for sand specifications. The sand should be capped at the top of the slab, and a retainer cast into the slab below the sand should be used to prevent sand loss beneath the slab.

G. Clearances

1. There should be a minimum clearance of 18 inches between beams or joists and soil.

2. In areas of high termite hazard, clearance between beams or joists and soil should be 36 inches.

H. Curtain Walls Where Necessary

1. Rodents may burrow under foundations of buildings without basements. Vertical curtain walls 2 feet (0.6 m) below the surface with an 8 inch (20 cm) horizontal "L" or flange directed away from the building are usually effective in preventing rats from burrowing under foundations. Construct curtain walls of 29-gauge corrugated iron, concrete, or bricks.

PART 2 - BUILDING EXTERIOR

A. Exterior Lighting

1. Choose light fixtures with sloping surfaces rather than horizontal surfaces to deter bird roosting and nesting.

2. Install bird spikes, "porcupine wire," netting, or similar devices to discourage birds from nesting on light fixtures.

3. Use bird exclusion devices, including wires, springs, nets, and electrical strips, to prevent birds from reaching light fixtures.

4. Motion detectors allow lights to be on for shorter amounts of time and can reduce accumulation of insects around lights.

5. Use timers to restrict light operation to high traffic times as appropriate. This may reduce the volume of insects attracted to the lights.

6. Use reflected light rather than direct light to illuminate doorways, as appropriate and allowed by local codes. Insects are more attracted to point sources of light and are therefore less likely to enter doorways.

7. Minimize direct lighting to high priority areas that maximize resident safety, especially near structures. All such lighting should meet local code requirements. This will minimize insect attraction to point source lights.

2. Use yellow lights ("bug" bulbs or sodium vapor lights, for example) in exterior areas where insect attraction to lights is an issue. Both intensity and color are important in insect attraction.

B. Miscellaneous

1. To minimize moisture accumulation, all downspouts and gutters should discharge at least one foot away from structure wall, using a connection to storm sewers, tail extensions, splash blocks, or dry wells.

2. Use gutters with downspouts on all buildings with eaves of less than 6 inches of horizontal projection except for gable ends and roofs above other roofs.

3. In areas of high rodent pressure, use flap valves to prevent rodents from entering downspouts. Mesh is also an option, but periodic cleaning will be necessary.

4. In areas of high rodent pressure, use cones or discs (typically metal) to prevent rodents from traveling up downspouts and pipes. Cones should be mounted with the wide end of the cone facing down and should be 12 inches in diameter and 12 inches long. Discs should be 18 inches in diameter.

5. Prevent mice and rats from climbing on exterior vertical pipes by applying a 12 inch band of glossy paint around the pipe.

6. Use expanded strainer leaf guards (made for keeping leaves out of downspouts) to keep rodents from entering open pipes.

7. To discourage rodent burrowing, install a gravel strip of 1-inch (2.5 cm) diameter or larger, laid in a band at least 2 feet (60 cm) wide and 1/2 foot (15 cm) deep.

8. Maintain plants, grass, and mulch several inches away from the foundation of buildings to minimizing nesting sites for ants.

9. Design exterior landscaping so it does not cause moisture build-up around the foundation. Consider use of drip irrigation. Maintain clearances between vegetation and exterior walls.

10. Use termite-resistant fence and post materials, including naturally durable wood, concrete and steel.

11. Install quality 1/4 or 1/2 inch galvanized hardware cloth from the bottom of the shed/porch/decks without perimeter foundations to 3-4 inches below the ground and then out in a perpendicular fashion at least 12 inches from the vertical line. To improve appearance of hardware cloth used under sheds, decks, and porches, cover with lattice after installation.

12. Seal all holes or joints in exterior or other cavity walls that are larger than 1/4 inch diameter to prevent access by mice. Where larger holes or joints are necessary they should be screened with 1/4" mesh or otherwise shielded from pest intrusion. Seal smaller holes to eliminate access from smaller pests. Use caulk (non-elastomeric, does not return to original shape when stretched or compressed) for openings of 1/4" diameter or less. Use an elastomeric sealant to close larger openings. Use a liquid sealer to close pores and hairline cracks.

13. “Cap” concrete masonry unit walls by filling the top row of blocks with cement to eliminate rodent access to the interior of the wall.

14. For standard stucco weep-screed construction, seal along foundation with 6-inch minimum rubberized asphaltic, self-adhesive membrane extending down over foundation 1-2 inches. At point above screed section, also seal back of flashing to foundation with generous bead of foundation mastic. Use vinyl weep screed in corrosive environments.

15. For offset weep-screed installation use weep-screed flashing with offset in the flashing equal to actual framing offset. Install per standard weep-screed construction procedures except use 8-inch minimum self-adhesive membrane extending to bottom of weep-screed. Use small bead of caulking between base of framing and flashing.

16. Design exterior structures like decorative screens, moldings and lattices, siding, awnings, window sills, signs, fire sprinkler pipes, and column capitals so that they do not provide opportunities for bird perching, roosting, or nesting especially near building entrances. Use smooth materials and avoid horizontal surfaces. Where necessary, retrofit existing structures with exclusion devices (looped wires, sheet metal spikes, springs, nets, etc.), although these devices are not foolproof and require maintenance. Openings in buildings, exposed rafters on overhanging dock roofs, or any likely perches in semi-enclosed areas can be screened with rust-proof, 3/4 inch wire or plastic mesh, or 1/2 inch mesh to also exclude rodents. Plastic netting is less durable and must be replaced more often.

17. Semi-enclosed alcoves or courtyards, especially with open roofs, provide ideal roosting and nesting opportunities for pigeons and other birds. If these structures must be included in the building design, include bird barriers and minimize horizontal surfaces.

PART 3 - FLOORS

A. In food preparation areas, use quarry tile, poured seamless epoxy floor, approved commercial grade vinyl, or similar materials to avoid moisture accumulation and harborage of insect pests.

B. Where floor drains are installed, slope surrounding floors 1/4 inch per foot to the drain

C. Floor drains should be easily accessible to enable cleaning and inspection. Floor drains should not be located under fixed kitchen equipment.

D. In areas of high rodent pressure, fit external doors with 26-gauge sheet metal kick plates 12 inches tall and mounted no more than 1/4 inch from the bottom of the door. Metal plates should not interfere with the swinging of the door.

E. Doors should fit tightly; the distance between the bottom of the door and the threshold should not exceed 1/4 inch. Use tight-fitting door sweeps if gaps are larger than 1/4 inch. If appropriate, use automatic door sweeps, which drop to seal against the floor when the door is closed. If automatic sweeps are not possible, bristle sweeps are preferable to rubber or plastic. If rodent pressure is high, protect rubber and plastic sweeps with metal kick plates installed on the outside of the door.

F. Specify air curtains (air doors) where doors are frequently open. Use models that start automatically when the door is opened to conserve energy. Properly installed and sized air curtains are typically about 80% effective in preventing insect entrance.

G. Use weather-stripping of all exterior doors to better seal against pest entry.

H. Openings around pipes or other structures that come through walls, floors and ceilings should be sealed. Caulk, foam, seal, paint, or otherwise fill any cracks and holes larger than the thickness of a credit card.

PART 4 - KITCHENS

A. Food storage should be elevated off the floor and away from walls to facilitate inspection and cleaning.

A. Wall-wall and wall-floor junctions should be coved to facilitate easier cleaning and prevent the accumulation of debris. Wall-ceiling junctions should be coved or sealed. Rubber or flexible plastic baseboard coving should be avoided, since it is very difficult to remove and inspect. Avoid cove base that is installed with adhesive. Choose coving that does not include an air gap under the curve, which could provide harborage for cockroaches.

B. Storage areas should have adequate lighting to allow efficient cleaning and easy pest inspection.

C. Provide access to voids above suspended ceilings for inspections and cleaning. In large buildings, provide walkways for this purpose.

D. Specify cabinets with legs to facilitate cleaning underneath. Legs should either be bolted to the floor with gaskets or sealant to eliminate gaps, or should be on wheels to enable easy moving.

E. Specify the use of wheeled stoves, mixers, refrigerators, and other appliances to encourage regular cleaning. Wheel fenders should include adequate clearance for cleaning around the wheels.

F. Locate drains so that they are accessible for cleaning.

G. When possible use flush thresholds in doorways. Thresholds collect dirt and food debris that can attract fruit flies or roaches.

H. When possible, locate food preparation areas on islands rather than against walls. Cleanup is generally easier around islands.

I. Install stainless steel backsplashes behind sinks and work surfaces for easier cleaning and avoid moisture buildup. Use sealant around edges.

J. Refuse disposal, recycling areas, and food delivery entrances should ideally be located away from frequently used entries. Refuse disposal and recycling areas attract flies and other pests, even when bins are well sealed and frequently cleaned. If the disposal area is adjacent to frequently used entries, such as those used for food deliveries, it is easier for the flies to enter the kitchen.

K. Use self-closing doors for food storage rooms to shut out rodents and some insect pests. Doors should be adequately sealed around the edges, with door sweeps or bottoms and no gaps over 1/4 inch.

L. Seal all penetrations through walls and floors, including wiring and pipe penetrations through wall framing at top and bottom plates. Use either an elastomeric sealant or fire block, depending on the size of the gap, its location, and local building codes. This is especially important in institutional kitchens where there is no tolerance for pest infestations. For larger gaps, including copper or stainless steel wool with foam may be necessary to exclude rodents.

M. Any wall storage, ornamentation, signage, bulletin boards, etc. should be sealed using elastomeric sealant or hung at least 1/4 inch from the wall to discourage pest harborage.

N. If rodent pressure is high, design food storage rooms without double walls, false ceilings, enclosed staircases, boxed plumbing, and voids under cabinets. This permits easy inspection and removes harborage.

O. Avoid use of ceramic outside corner tiles. Ceramic tiles located in heavily used areas are highly prone to breakage. Broken tiles provide access to voids that can harbor pest insects. Durable outside corners, such as metal or plastic, are preferred alternatives.

PART 5 - UTILITIES, HVAC, AND CHUTES

A. Use escutcheons, cement mortar, or copper mesh or hardware cloth embedded in patching plaster to seal any openings around utility or HVAC penetrations.

B. Where rodent pressure is not high, or with gaps < ¼”, use silicone sealant to seal around utility penetrations to deter insect movement.

C. Outside air intakes or vents for wall-mounted heaters, air conditioners, and exhaust fans should be screened to exclude insects a variety of pests. Use 10-mesh screen or smaller and design/install the screen so that it can be easily removed for cleaning.

D. Use foam gaskets behind electrical cover plates to seal off access to pests, particularly in pest-sensitive areas such as kitchens.

E. There should be adequate space and access for cleaning around utility penetrations.

F. Trash and laundry chutes should have tight-fitting doors. Avoid any gaps between the door and the surrounding wall. Use metal garbage and laundry chutes with a circular cross-section to avoid the accumulation of debris in hard-to-clean corners. Hopper doors into vertical trash chutes should be large enough to fit a full trash bag, to avoid the accumulation of debris from torn bags and keep chutes cleaner.

END OF SECTION 10 81 00

SECTION 11 53 00 - LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for safety equipment used in or in support of laboratories.
B. UT recognizes that project conditions and requirements vary, thus precluding absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.2 Related Standards

A. 11 53 13 – Laboratory Fume Hoods
B. 11 53 00 – Laboratory Renovations

1.3 Reference Standards

A. ANSI Z358.1-1998
B. NFPA 45, 2000C. NFPA 30, 2000
C. OSHA 29 CFR 1910.106
D. OSHA 29 CFR 1910.1450
E. Centers for Disease Control (CDC)/ National Institutes of Health (NIH) Biosafety in Microbiological and Biomedical Laboratories, 4th edition
F. NSF 49 (most current version)
G. CRC Handbook of Laboratory Safety, 5th edition
H. Prudent Practices in the Laboratory, National Research Council

1.4 General Requirements For All Labs (chemical and biological)

A. Each laboratory shall contain a sink for hand washing.
B. The laboratory shall be designed so that it can be easily cleaned.
C. Laboratory furniture shall be capable of supporting anticipated loading and uses. Spaces between benches, cabinets, and equipment are accessible for cleaning.

1.5 GENERAL VENTILATION

A. The general ventilation shall: be used for input to local ventilation devices; not be relied on for protection from toxic substances released into the lab; ensure that lab air is continually replaced, preventing the increase of air concentrations of toxic substances during the working day; direct airflow into the lab from non-lab areas and out to the exterior of the building
B. When local exhaust systems such as hoods are used as the primary method of control, six to twelve room air changes per hour are adequate. (Ten – twelve room air changes per hour for moderate – high-risk laboratories.)

1.6 VENTILATION DEVICES

A. Fume hoods: Located 10 feet (minimum) from exit doors.
B. Exhaust air from glove boxes and isolation rooms shall be passed through scrubbers or other treatment before being release into the regular exhaust system.
C. Biological Safety Cabinets must be constructed, installed, and tested in accordance with the current version of the National Sanitation Foundation (NSF) Standard 49.

1.7 LAB BENCHES

A. Provide for at least 40 – 48 inches of clearance between lab benches and everything else in the lab, e.g., other lab benches, walls, and fume hoods.

B. Epoxy resin countertops – typical.
C. Provide Stainless Steel counters at locations with radioactive materials.
D. Bench tops shall be impervious to water and are resistant to moderate heat and the organic solvents, acids, alkalis, and chemicals used to decontaminate the work surface and equipment.

1.8 EMERGENCY SHOWERS AND EYEWASHES

(The following requirements apply to both emergency showers and eyewashes.)

A. The valve shall be designed so that the water flow remains "on" without requiring the use of the operator's hands (hands-free) and shall remain activated until intentionally shut off.
B. Valve shall be simple to operate and go from "off" to "on" in 1 second or less.
C. Equipment shall be in accessible locations that require no more than 10 seconds to reach from any laboratory work area.
D. Each location shall be identified with a highly visible sign.
E. Water shall be tepid, moderately warm.
F. Only potable water shall be used for eyewashes and showers.

1.9 EMERGENCY SHOWERS

A. The shower shall be located so that a water column is provided that is not less than 82 inches or more than 96 inches in height from the surface on which the user stands.
B. Often, the best location for a shower is in the main corridor.
C. The center of the spray pattern shall be located at least 16 inches from any obstruction.
D. The shower shall be capable of delivering a minimum of 20 gallons of water per minute.

1.10 EYEWASHES

A. An eyewash facility shall be readily available to all labs.
B. Eyewashes shall be installed close to the showers (in addition to other laboratory locations) so that, if necessary, the eyes can be washed while the body is showered.
C. The eyewash shall be positioned with the water nozzles 33 inches to 45 inches from the surface on which the user stands and 6 inches minimum from the wall or nearest obstruction.
D. There shall be no sharp projections anywhere in the operating area of the unit.
E. Eyewashes shall be designed to provide water to both eyes simultaneously, be a continuous flow design, and operate hands-free (although they can be actuated by hand).
F. Eyewashes shall be capable of delivering to the eyes not less than 0.4 gallons of water per minute.
G. Eyewash nozzles shall be protected from airborne contaminants and the protector cap's removal shall not require a separate motion by the operator.
H. Eyewashes shall be drained or be of the swivel type that allows the water to run directly into the sink. (Eyewashes shall be activated weekly to purge bacteria and debris from the water.)

1.11 STORAGE UNITS

1.12 FLAMMABLE STORAGE CABINETS

A. Flammable cabinets shall be specified for all labs that may use flammable chemicals in quantities greater than ten gallons.
B. Flammable cabinets shall meet NFPA 30 and OSHA 29 CFR 1910.106 standards.
C. Flammable cabinets are not required to be vented. Vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the manufacturer of the cabinet.
D. If vented, the cabinets shall be vented directly to the outdoors in a manner that will not compromise the specified performance of the cabinet and in a manner that is acceptable to The University Fire Marshall.
E. Flammable cabinets shall be marked in conspicuous lettering: "Flammable - Keep Fire Away."

1.13 CORROSIVE CABINETS

A. Corrosive cabinets shall be provided for labs that need to store corrosive material.

1.14 BASE CABINETS FOR FUME HOODS

A. Wherever possible, flammable storage cabinets shall be used as the base cabinets for fume hoods. If flammable storage cabinets are not used as the base cabinet, then the cabinet shall be constructed to withstand fire conditions so that the hood remains supported.

B. If vented storage cabinets are provided under the hood, they shall be vented in the following manner:

1. Do not cut the work surface for venting the base cabinets.
2. Vent through the side wall of the hood with 1.5 to 2-inch national pipe thread (npt) galvanized pipe.
3. The tap into the exhaust shall be done above the hood.
4. The tap from the back of the cabinet shall be at the lower part of the cabinet and as supplied by the cabinet manufacturer.

C. See attached Specification Sheet

1.15 COMPRESSED GAS CYLINDER CABINETS

A. Ventilated compressed gas cylinder cabinets shall be specified for labs that will use certain hazardous gases that are identified by The University, in larger than lecture bottle quantities (or where there are no fume hoods in which to store small cylinders). Refer to, www.utexas.edu/safety/ehs Environmental Health & Safety website, or EH&S at 471-3511 for a list of gases requiring ventilation.

B. Ventilated cabinets shall comply with International NFPA Standards Fire Code.

1.16 LAB SAFE REFRIGERATORS

A. If refrigerators are provided as part of the project, they will be Lab safe for labs that will utilize cold storage of flammable chemicals.

B. Refrigerators shall be manufactured as "lab safe," but need not be "explosion-proof." SPECIAL WORK AREAS.

Note: Cold rooms and warm rooms shall have provisions for rapid escape in the event of electrical failure.

BIOLOGICAL LABORATORIES (ONLY)

In addition to the equipment and design requirements described above, the following requirements are specifically for biological labs. (Refer to EH&S at 471-3511 to determine the appropriate biosafety level.)

1.17 LABORATORY FACILITIES FOR LABS AT A BIOSAFETY LEVEL 1

A. Each laboratory shall contain a sink for hand washing.

B. The laboratory shall be designed so that it can be easily cleaned.

C. Bench tops shall be impervious to water and are resistant to moderate heat and the organic solvents, acids, alkalis, and chemicals used to decontaminate the work surface and equipment.

D. Laboratory furniture shall be capable of supporting anticipated loading and uses. Spaces between benches, cabinets, and equipment are accessible for cleaning.

E. If the laboratory has windows that open to the exterior, they shall be fitted with fly screens.

1.18 LABORATORY FACILITIES FOR LABS AT A BIOSAFETY LEVEL 2

(*These are in addition to all of the requirements for Biosafety Level 1.)*

A. Chairs and other furniture used in laboratory work shall be covered with a non-fabric material that can be easily decontaminated.

B. Class II biological cabinets may be required (contact EH&S for assistance). If biological cabinets are used, install them in such a manner that fluctuations of the room supply and exhaust air do not cause the biological safety cabinets to operate outside their parameters for containment. Locate biological safety cabinets away from doors, from windows that can be opened, from heavily traveled laboratory areas, and from other potentially disruptive equipment so as to maintain the biological safety cabinets' air flow parameters for containment.

C. An eyewash facility shall be readily available.

D. Illumination shall be adequate for all activities, avoiding reflections and glare that could impede vision.

E. There shall be an inward flow of air without recirculation to spaces outside the laboratory.

1.19 LABORATORY FACILITIES FOR LABS AT A BIOSAFETY LEVEL 3

(These are in addition to all of the requirements for Biosafety Level 1 and Biosafety Level 2.)

A. The laboratory shall be separated from areas that are open to unrestricted traffic flow within the building, and access to the laboratory is restricted. Passage through a series of two self-closing doors is the basic requirement for entry into the laboratory from access corridors. A clothes change room (shower optional) may be included in the passageway.

B. Each laboratory room shall contain a sink for handwashing. The sink is hands-free or automatically operated and is located near the room exit door.

C. The interior surfaces of walls, floors, and ceilings of areas where BSL-3 agents are handled shall be constructed for easy cleaning and decontamination. Seams, if present, shall be sealed. Walls, ceilings, and floors shall be smooth, impermeable to liquids, and resistant to the chemicals and disinfectants normally used in the laboratory. Floors shall be monolithic and slip-resistant. Use coved floor coverings. Penetrations in floors, walls, and ceiling surfaces shall be sealed. Openings such as around ducts and the spaces between doors and frames shall be capable of being sealed to facilitate decontamination.

D. Windows in the laboratory shall be closed and sealed.

E. A method for decontaminating all laboratory wastes shall be available in the facility and utilized, preferably within the laboratory (i.e., autoclave, chemical disinfection, incineration, or other approved decontamination methods).

F. Biological safety cabinets are required and are located away from doors, room supply louvers, and heavily-traveled laboratory areas.

G. A ducted exhaust air ventilation system shall be provided. This system shall create directional airflow which draws air into the laboratory from “clean” areas and toward "contaminated" areas. The exhaust air shall not be recirculated to any other area of the building. Filtration and other treatments of the exhaust air are not required but may be considered based on site requirements, and specific agent manipulations and use conditions. The outside exhaust shall be dispersed away from occupied areas and air intakes, or the exhaust shall be HEPA-filtered. A visual monitoring device that indicates and confirms directional inward airflow shall be provided at the lab entry. Consideration shall be given to installing an HVAC control system to prevent sustained positive pressurization of the lab. Audible alarms shall be considered to notify personnel of HVAC system failure.

H. HEPA-filtered exhaust air from a Class II biological safety cabinet can be recirculated into the laboratory if the cabinet is tested and certified at least annually. When exhaust air from Class II safety cabinets is to be discharged to the outside through the building exhaust air system, the cabinets shall be connected in a manner that avoids any interference with the air balance of the cabinets or the building exhaust system (e.g., an air gap between the cabinet exhaust and the exhaust duct). When Class III biological safety cabinets are used they shall be directly connected to the exhaust system. If the Class III cabinets are connected to the supply system, it is done in a manner that prevents positive pressurization of the cabinets.

I. Continuous flow centrifuges or other equipment that may produce aerosols are contained in devices that exhaust air through HEPA filters before discharge into the laboratory. These HEPA systems are tested at least annually. Alternatively, the exhaust from such equipment may be vented to the outside if it is dispersed away from occupied areas and air intakes.

J. The Biosafety Level 3 facility design and operational procedures shall be documented. The facility shall be tested for verification that the design and operational parameters have been met prior to operation.

K. Facilities shall be re-verified, at least annually, against these procedures as modified by operational experience.

L. Additional environmental protection (e.g., personnel showers, HEPA filtration of exhaust air, containment of other piped services, and the provision of effluent decontamination) shall be considered if recommended by the agent summary statement, as determined by risk assessment, the site conditions, or other applicable federal, state, or local regulations.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 EMERGENCY SHOWERS - TESTING

A. When the shower is installed, test it in accordance with the following procedures:

1. With the unit correctly connected to the water source and the valve(s) closed, visually check the piping for leaks.
2. Open the valve to the fully open position. The valve shall remain open without requiring further use of the operator’s hands.
3. Measure the shower. The face of the showerhead shall be not less than 82 inches nor more than 96 inches from the surface on which the user stands.
4. With the valve in the “full on” position, measure the diameter of the spray pattern. It shall be a minimum of 20 inches at 60 inches above the standing surface. The center of the spray shall be at least 16 inches from any obstructions.
5. Delivered water temperature shall be tepid.

3.2 EYEWASHES – TESTING

A. When the eyewash is installed, the valve shall be operated to determine that both eyes would be washed simultaneously at a velocity low enough to be non-injurious to the user.

B. Delivered water temperature shall be tepid.

SECTION 11 53 13 – LABORATORY FUME HOOD

PART 1 - GENERAL

1.1 Scope of Standard

A. This standard provides the requirements and the specific preferences concerning fume hoods at UT Health.

B. UT Health recognizes that project conditions and requirements vary, thus precluding absolute adherence to the items identified herein in all cases. Deviations to the UT Health Design and Construction Standard shall submit a Standards Exception Request and receive approval before deviating from the standard.

C. The specifications contained herein include the requirements for systems and materials utilized for fume hood equipment at UT Health. It is the intention of this document to provide a minimum standard for fume hoods at UT Health so as to provide a high level of safety; it is not intended to be a guide specification.

D. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis for design. The responsibility of the engineer is to apply the principles of this section such that UT Health may achieve a level of quality and consistency in the design and construction of its facilities. Deviations from these specifications must be justified through LCC analysis and submitted to UT Health through the Standards Exception Request for approval.

E. This standard excludes Biological Safety Cabinets (BSCs), which are not chemical fume hoods. BSCs are used for biological work.

1.2 Related UT Standards

A. 11600 Laboratory Equipment

B. 11500 Laboratory Renovations

C. 23 31 00 HVAC Ducts

D. 22 40 00 Plumbing Fixtures

E. 23 09 00 Digital Controls [does not currently address laboratory or fume hood ductwork requirements]

F. 12 35 53 Laboratory Casework

G. Divisions 22, 23, and 26 for connecting service utilities

H. Laboratory Design Criteria

1.3 Applicable Codes and Regulations

A. OSHA 29 CFR 1910.1450: Occupational exposure to hazardous chemicals in laboratories

B. OSHA 29 CFR 1910 Subpart Z: Toxic and Hazardous Substances

C. NFPA 45 (version per state fire marshal): Standard on Fire Protection for Laboratories Using Chemicals

D. NFPA 30 (version per state fire marshal): Flammable and Combustible Liquids Code

E. 7 Texas Administrative Code (TAC) 341.016: Sanitation of Businesses; Occupational Health and Safety

F. Texas Accessibility Standards

G. NFPA 70 (version per state fire marshal): National Electrical Code

H. NFPA 90A (version per state fire marshal): Standard for the installation of air-conditioning and ventilating systems

I. NFPA 91 (version per state fire marshal): Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids

1.4 Reference Standards (current version)

A. ANSI/AIHA Z9.5 – Laboratory Ventilation

B. ANSI/AIHA Z9.7 – Recirculation of Air from Industrial Process Exhaust Systems

C. ASHRAE 110 – Method of Testing Performance of Laboratory Fume Hoods

D. ASHRAE Laboratory Design Guide

E. Prudent Practices in the Laboratory – Handling and Management of Chemical Hazards

F. ACGIH Industrial Ventilation – A Manual of Recommended Practice for Design

G. SEFA 1 The Scientific Equipment and Furniture Association, Recommended Practices for Laboratory Fume Hoods

H. UL 1805 Underwriters Laboratories Inc., Standard for Laboratory Hoods and Cabinets

1.5 Scope of Work

A. Fume hoods shall be provided where laboratory tasks involve the generation of hazardous dust, vapors or gases, etc. as required by the codes and regulations of this standard.

B. Fume hoods per this specification refer to Laboratory Fume Hoods as defined by SEFA 1 Recommended Practices for Laboratory Fume Hoods.

C. The fume hoods used at UT Health shall conform to the codes and standards listed in this section.

1.6 General Requirements:

A. Fume hood openings shall be located:

1. In close proximity to where chemicals are stored or used.
2. More than 5 feet away from supply air diffusers.
3. At least 8 feet away from exits, doorways, and operable windows.
4. Away from main thoroughfares in the laboratory where air currents and cross drafts may interfere with fume hood airflow.
5. 4” away from a sidewall or other solid structures, such as building support columns.
6. Away from desks and non-fume-hood-related activities.

B. Quantity: Consider the number of users per hood, frequency of use, and percentage of time working at a hood when determining the number of hoods. Labs with intensive chemical use require to have 4 linear feet of hood space per lab worker.

C. Air flow rates must be adjusted after installation of a fume hood:

1. Before a new fume hood is put into operation, an adequate supply of make-up air ~~must~~ be provided to the lab.

2. Maintain negative pressure in the lab and directional airflow from the corridor into the lab; supply air volume shall be less than the exhaust from the lab.

D. Supply air diffusers may not be located within 5 feet of the installation location face of a fume hood.

1. If approved through the Standards Exception Request, the PSP may provide low-velocity discharge type diffusers with demonstrated performance to minimize disturbance at the face of the hood in small lab spaces where the required clear distance is not feasible.

E. A Standards Exception Request shall be submitted for labs requiring positive pressurization.

F. Adjustment of building flow rates and dampers to ensure proper fume hood operation requires a test and balance report. The report must be supplied to EHS.

1.7 Accessibility

A. ADA/TAS accessible hoods shall be required for all teaching labs at the percentage specified by TAS.

1.8 PAssing ASHRAE 110 testing criteria:

A. No observed smoke release when testing with visible smoke; no reverse flow of smoke is evident within six inches of the plane of the sash when generated at least six inches behind the plane of the sash; no lazy flow into hood along openings; no slow capture and clearance – greater than 2 minutes for clearance; no observed potential for escape.

B. Hood face velocity average >75 – <110 ft/min (75 ft/min minimum) for low flow hoods and >100 -<115 ft/min (100 ft/min minimum) for standard flow hoods at 18” sash height.

C. Average concentration for SF6 is no more than 0.05 ppm average and <0.10 ppm peak (for ‘as installed).

D. No single face velocity measurement shall exceed +/-20% of the average face velocity.

E. Cross drafts are allowed to be <50% of average face velocity. Any values greater than 30 ft/min must be justified in the test and balance report that this higher flow rate is not disturbing proper containment in the hood.

F. VAV response within 5 seconds and return to +/- 10% of average face velocity or flow.

G. VAV response to sash ‘open’ movement has <20% variation.

H. The hood is configured as the manufacturer intended it to be.

1.9 Submittals

A. The Project Manager shall review and distribute all fume hood product data, shop drawings, and test reports for review by Environmental Health and Safety (EHS) and others, as appropriate.

1.10 Quality Assurance

A. Factory tested and manufactured in accordance with ASHRAE 110.

PART 2 - PRODUCTS

2.1 Fume Hood Types

<u>Low-flow fume hoods are considered the standard for construction/renovation projects.</u>

A. Low-flow/high-performance/high-efficiency fume hoods

1. New hoods for standard bench top use shall be low-flow hoods

2. Acceptable Models:

   a. Kewaunee Supreme Air LV
   b. Labconco Protector Xstream

3. Design target face velocity is 80 feet per minute with 18" sash opening.

B. Conventional fume hoods

1. Acceptable Models:

   a. Kewaunee Supreme Air
   b. Labconco Protector

2. Design target face velocity with 18” sash opening is 100 feet per minute (ft/min) face velocity.

C. Any hood larger than 8' must seek approval through the standards exception request process.

D. Floor-mounted fume hoods enable access from the floor to the top of the hood interior (walk-in) (requires approval by EHS prior to CD60).

1. For use with large apparatus in a fume hood.

2. Sashes are horizontal or vertical for ease of access when transporting apparatus into the hood.

3. Not for use with work tables or desks that may adversely affect fume hood performance.

4. Shall have a face velocity of 100 ft/min at 18”.

5. Base of the hood shall be constructed with a base contiguous with the sidewalls and a 1” minimum vertical lip sufficient to contain spills inside the hood.

E. Corrosive resistant polypropylene fume hood (requires approval by EHS prior to CD60)

1. A special use hood for high corrosive applications, sometimes used in cleanroom environments.

2. Available with High-Efficiency Particulate Air (HEPA) filtration when product protection is required.

3. Available as a conventional or by-pass fume hood without HEPA filtration.

F. Ductless fume hoods (hoods with an exhaust fan and exhaust filters as an integral part of the hood and discharge the exhaust directly into the lab).

1. This type of hood requires a written hazard assessment, in accordance ~~to~~ with ANSI/AIHA Z9.7 and Z9.5, to be submitted to EHS for approval prior to CD60.

G. Hydrofluoric (HF) acid fume hoods

1. Shall be on a dedicated system.

2. Shall not be installed over a flammable liquid storage cabinet.

3. Shall have the following materials for construction

    a. Constructed of compatible non-reactive materials (such as polyvinyl chloride (PVC) lined stainless steel countertop).

    b. Interior shall be non-metallic, non-fiberglass, non-glass.

    c. Sash material shall be polycarbonate resin (Lexan) or similar sash. Glass is not acceptable.

    d. Lens on light fixture shall be polycarbonate resin (Lexan).

    e. PVC liners for hoods with HF acid digestions.

H. Perchloric acid fume hoods

1. Shall have a water wash-down system in the hood and exhaust system and include a spark-resistant exhaust fan. This type of hood requires a written hazard assessment in accordance ~~to~~ with ANSI/AIHA Z9.5 for EHS approval prior to CD60.

2. Heated perchloric acid shall only be used in a laboratory hood specifically designed for its use and identified as “For Perchloric Acid Operations.” (Exception: Hoods not specifically designed for use with perchloric acid shall be permitted to be used where the vapors are trapped and scrubbed before they are released into the hood.)

3. Perchloric acid hoods and exhaust ductwork shall be constructed of materials that are acid resistant, nonreactive, and impervious to perchloric acid.

4. The exhaust fan should be acid resistant and spark-resistant. The exhaust fan motor should not be located within the ductwork. Drive belts should not be located within the ductwork. Ductwork for perchloric acid hoods and exhaust systems shall take the shortest and straightest path to the outside of the building and shall not be manifolded with other exhaust systems. Horizontal runs shall be as short as possible, with no sharp turns or bends. The duct work shall provide a positive drainage slope back into the hood. The duct shall consist of sealed sections. Flexible connectors shall not be used. Ductwork must be labeled with at least 3” bold letters stating “Perchloric Acid Exhaust”, visible from maintenance access points and labeled after each duct turn or bend.

5. Sealants, gaskets, and lubricants used with perchloric acid hoods, duct work, and exhaust systems shall be acid resistant and nonreactive with perchloric acid.

6. A water spray system shall be provided for washing down the hood interior behind the baffle and the entire exhaust system. The hood work surface shall be watertight with a minimum depression of 13 mm (1⁄2 inch) at the front and sides. An integral trough shall be provided at the rear of the hood to collect wash-down water.

7. Spray wash-down nozzles shall be installed in the ducts no more than 5 ft. apart. The ductwork shall provide a positive drainage slope back into the hood. Ductwork shall consist of sealed sections, and no flexible connectors shall be used.

8. Project maintenance schedule shall include the required periodical washed down thoroughly with water to remove all residues in the hood, duct system, fan, and stack.

9. The hood surface should have an all-welded construction and have accessible rounded corners for cleaning ease.

10. The hood baffle shall be removable for inspection and cleaning.

11. Each perchloric acid hood must have an individually designated duct and exhaust system.

I. Auxiliary air fume hoods (hoods with an external supply air plenum at the top of the hood) are <u>not</u> allowed.

J. Radioactive Material Use:

1. Laboratory hoods used for radioactive materials shall be identified with the radiation hazard symbol.

2. Fume hoods intended for use with radioactive isotopes must be constructed of stainless steel or other materials that will not be corroded by the chemicals used in the hood.

3. The interior of all radioisotope hoods must have coved corners to facilitate decontamination.

4. The hood exhaust may require filtration by HEPA or Charcoal HEPA filters. Where such is the likelihood, the hood must have a bag-out plenum for mounting such filters and fan capacity for proper operation of the hood with the filter installed. The most appropriate location for the plenum is near the exhaust port of the fume hood (i.e., proximal to the hood).

5. Where required by identified isotope use, hoods shall have sashes with horizontal sliding glass panels mounted in a vertical sash.

6. Shielding must be determined by identified isotope used and EHS must be consulted to verify shielding design. The cabinet on which the hood is installed shall be adequate to support shielding for the radioactive materials to be used therein.

2.2 Fume hood components and features

A. Work surfaces shall be epoxy resin and recessed at least ¼ inch beginning 6” from the hood face.

B. Fume hood interior surfaces shall be constructed of corrosion-resistant, non-porous, non-combustible materials, and should be smooth and impermeable, with rounded corners. These materials shall have a flame spread index of 25 or less when tested in accordance with NFPA method 255, Standard Method of Test of Surface Burning Characteristics of Building Materials. Asbestos-containing materials are not allowed.

C. There must be a horizontal bottom airfoil inlet at the front of the hood.

D. Work Top/Surface

1. Spill top protection

   a. Work surfaces must have recessed work surfaces or spill containment lips to help contain minor liquid spills within the hood. All penetrations in the work surface must be protected from a spill by a containment lip. The depth of the recessed work surface or containment lip should provide the following order of protection:

      1) Vacuum penetration must be avoided and have the highest protection, typically 1" or more above the work surface.

      2) Perimeter /user protection must be avoided but can be lower than the protection provided to the vacuum penetration, typically 3/8" or more lip around the work surface.

      3) Cupsink protection is the lowest spill height protection on the bench.

2. Cupsink will be provided when approved by a Standards Exception Request. The following criteria are required if cup sinks have an approved Standards Exception Request.

a. When installed, cup sinks shall drain to the building lab drain system, where present, or to the sanitary sewer where a lab drain system does not exist unless discharge of laboratory chemicals to the sanitary sewer is restricted. EHS must be consulted on drain determination.

b. Cupsinks shall be located next to a side wall with the sink centerline 6”-14” from the face of the hood. Cupsinks shall be centered under the tips of cold-water faucets.

c. Cupsinks, drain lines and connections shall be acid/solvent resistant, and have a vertical lip of at least ¼ inch to prevent spills into the cup sink.

d. Cupsink faucet shall have a vacuum breaker outside the fume hood. (FOM to confirm the desired model).

E. Sashes

1. Sashes shall be constructed of transparent shatterproof material, suitable for the intended use.

2. Sash-limiting devices (stops) shall be installed at an 18-inch opening for vertical sashes.

3. Sash drive shall be stainless-steel cable or hardened carbon steel chain and sprocket.

4. Counterbalance vertical sliding sash with sash weight and the drive system must hold the sash in place regardless of position.

F. Airflow monitors and alarms

1. An airflow indicator shall be provided and located so that it is visible from the front of the fume hood.

2. An accurate face velocity alarm indicator that alerts users to improper exhaust flow is required for new fume hoods and existing hoods in labs being renovated. Location of face velocity alarm instrument shall be located to avoid interference from the lab user’s countertop operations.

3. Provide a local audible and visual alarm device capable of detecting a drop or rise in airflow through the hood. That is, if the exhaust falls below or rises above-pre-set levels, the alarm will sound and the alarm light will come on. The local audible and visual alarm shall have capabilities for remote monitoring hookup in the campus building automation system.

4. All parts of the system which are apt to be in contact with vapors or gases in the hood shall be chemically resistant, i.e., the controller, sensing device, wiring, etc.

5. Provide a means to mute the audible alarm. The silence device shall not turn off the warning light. An on/off switch for the alarm is prohibited.

6. Provide a means for setting the alarm set point to the exhaust level desired. This adjustment shall be "internal" so that it is not readily adjustable by hood users.

7. The low-level alarm point is 60 ft/min for low-flow fume hoods and 80 ft/min for conventional fume hoods. The high-level alarm point is 140 ft/min for low-flow fume hoods and 140 ft/min for conventional fume hoods.

G. Emergency Purge Feature: Where required by EHS, low flow fume hoods shall be capable of temporarily increasing the airflow beyond the operating regular face velocity to purge the air from the fume hood in the event of a spill inside the hood. Emergency purge shall be initiated by an Emergency Purge button on the fume hood display panel and canceled by pressing the button a second time. When an emergency purge is initiated, visual and audio alarms shall also initiate.

H. Labeling

1. Each hood shall bear an Equipment Identification (EQ ID) sticker issued by UT Health Facilities Services.

2. Each hood shall be labeled with an identifier for the exhaust fan(s) it is served by.

I. EHS shall be notified of the test and balance testing schedule. After the test and balance, EHS shall be notified to verify face velocity and certify the fume hood.

J. Base Cabinet shall meet standards for either flammable liquid storage, corrosive storage, or both.

1. Flammable cabinets should be self-closing with auto-latch. A spill containment pan on the cabinet floor with a 2-inch deep liquid-tight spill containment pan is required. Each cabinet should be marked "FLAMMABLE" in letters not less than 2 inches in height and in a color that is contrasting with the background cabinet color.

2. Flammable cabinets shall not be vented but be prepared for venting with a flame arrestor screen at vent inlets and bungs in place to provide a seal.

3. Flammable cabinets must meet NFPA 30 requirements and should be listed and labeled as such.

4. Corrosive cabinets should be lined with 1/4" polyethylene, polypropylene, epoxy, or glass-fiber-reinforced polyester lining material. Each cabinet should be labeled "CORROSIVE" in letters no less than 2" and in a color contrasting with the cabinet color.

5. Corrosives cabinet vent pipes shall be polyethylene, polypropylene, rigid polyolefin, or flexible reinforced PVC vent pipes connected behind the rear of the fume hood baffle. The vent shall not penetrate the hood work surface. Provide flame arrestor screen at vent inlets.

6. Vacuum pump cabinet must include a sliding shelf rated to hold an owner-specified pump.

   a. Vacuum pump cabinets must have:

      1) lined internally with appropriate material for sound deadening and easy cleaning.
      2) 120VAC / 20-amp duplex receptacle mounted on inside cabinet back and a toggle switch mounted in the top front rail of the cabinet.
      3) a vent pipe for venting or access to the hood above.
      4) some type of opening (for example louvers) at front of the cabinet to allow for air to be pulled through the cabinet to dissipate heat.
      5) a pan should be provided at the bottom of the cabinet to catch any oils from the pump itself.

K. Utilities

1. Electrical utilities shall be located at readily accessible locations outside the hood. If additional utilities are required, they may be located inside the hood provided they have outside cut-offs and can be connected and operated without potentially subjecting the hood user to exposure to hazardous materials. Electrical outlets must be GFCI-protected.

2. Based on owner request, provide pre-wired and pre-piped for utilities as specified in the design documents.

3. For new installations or modifications of existing installations, controls for laboratory hood services (eg., gas, air, and water) should be located external to the hood and within easy reach.

4. Shutoff valves for services, including gas, air, vacuum, and electricity shall be outside of the hood enclosure in a location where they will be readily accessible in the event of a fire in the hood. The location of such a shut-off shall be legibly lettered in a related location on the exterior of the hood.

L. Light

1. Fume hood shall have the capability to replace the fume hood lamp externally, without reaching into the hood.

2. LED lighting required.

3. Lights should be in vapor-proof housing and shielded from fume hood interior with 1/4 " laminated glass or 3 mm thick tempered glass, sealed into the hood with chemical-resistant rubber gasket(s).

M. Tissue Screen: Chemical-resistant tissue screen shall be installed.

N. Energy Conservation

1. For a fully DDC building, zone presence sensors shall be included on fume hoods in teaching labs to allow for reduced air flow during unoccupied times.

2. Automatic sash closures shall be used. These systems shall have obstruction sensing capable of stopping travel during sash closing operations without breaking glassware, etc.

O. Laboratory hoods shall not have an on/off switch located in the laboratory.

P. Special purpose fume hoods (radioactive, perchloric, corrosive and ductless) require a label indicating the special use.

Q. Drying ovens shall not be placed under fume hoods.

PART 3 - EXECUTION

3.1 Field Quality Control

A. Testing and balance

1. Owner representative and testing/balancing agency shall schedule and attend a pre-test meeting with the Owner, EHS, and FOM representatives to coordinate the contractor’s testing of fume hoods and the Owner’s confirmation testing. This may include side-by-side air velocity testing of at least one fume hood with the testing/balancing provider and EHS specialist.

B. Commissioning

1. Commissioning provider or project mechanical engineer (for projects without a commissioning provider) will verify in writing that all fume hood components and accessories are provided and functioning in accordance with the manufacturer’s specifications and as designed.

C. Field test installed fume hoods according to ASHRAE 110 as follows prior to close out:

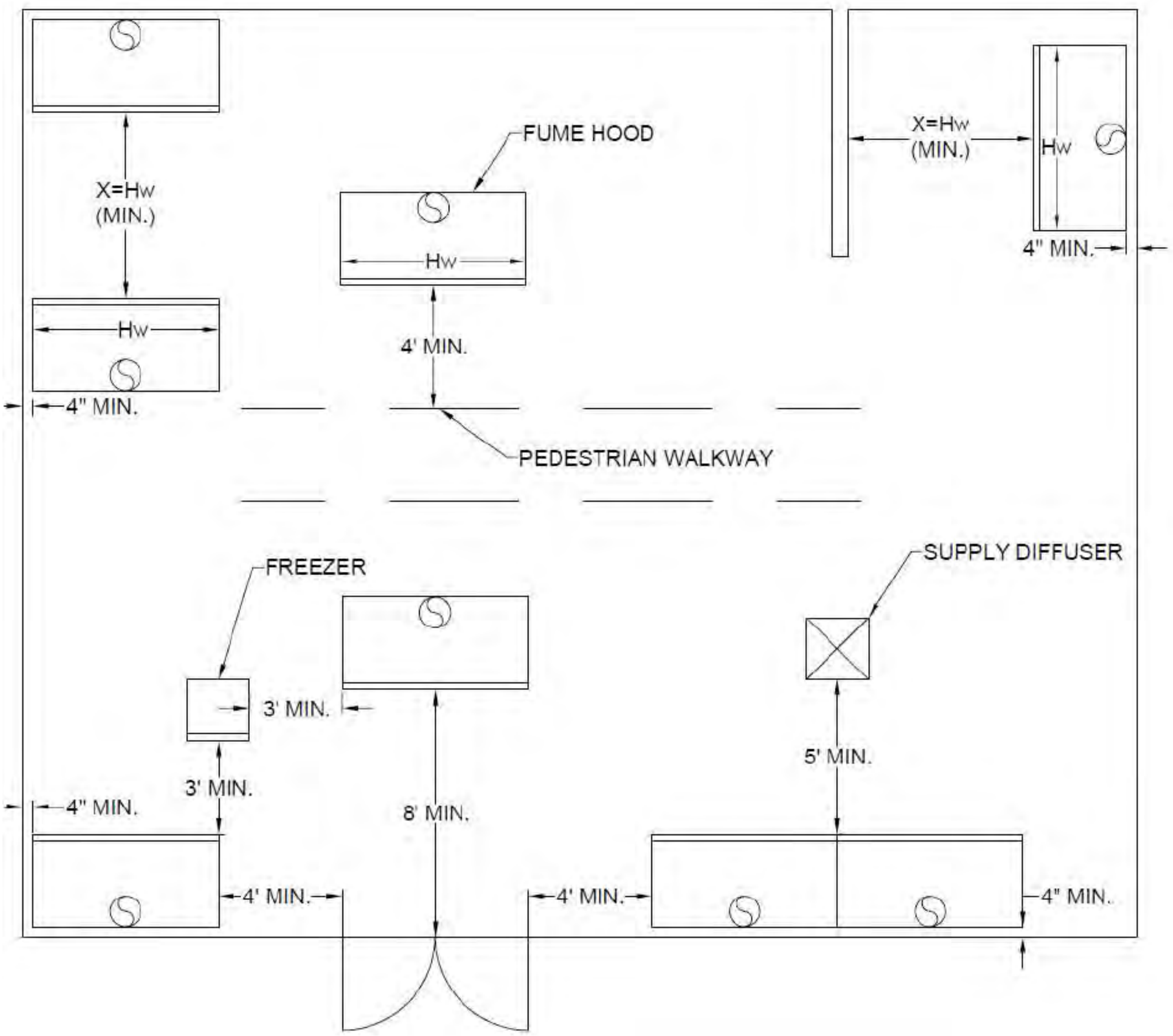
1. For new construction: All hoods must be ASHRAE 110 tested. Deviations from these guidelines must be justified by the project designers through a risk assessment to justify to a decrease in the overall quantity of hoods requiring ASHRAE testing analysis and submitted to UT for approval.

2. For renovations: EHS will conduct a risk assessment to determine which hoods require ASHRAE testing.

3.2 INSTALLATION

A. The fume hoods and accessories shall be installed and connected to the building services in accordance with the manufacturer's printed instructions and in accordance with all applicable codes.

END OF SECTION 11 53 13


FUME HOOD
X=Hw
(MIN.)
Hw
4" MIN.
4' MIN.
PEDESTRIAN WALKWAY
FREEZER
3' MIN.
SUPPLY DIFFUSER
5' MIN.
8' MIN.
4' MIN.
4" MIN.

SECTION 12 24 13 – ROLLER SHADES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Manually operated sunscreen roller shades.

B. Manually operated room-darkening shades.

C. Manually operated double-roller sunscreen and room-darkening shades.

1.2 RELATED SECTIONS

A. Section 06100 - Rough Carpentry: Wood blocking and grounds for mounting roller shades and accessories.

B. Section 09260 - Gypsum Board Assemblies: Coordination with gypsum board assemblies for installation of shade pockets, closures and related accessories.

C. Section 09510 - Acoustical Ceilings: Coordination with acoustical ceiling systems for installation of shade pockets, closures and related accessories.

D. Division 16 - Electrical: Electric service for motor controls.

1.3 REFERENCES

A. ASTM G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. NFPA 70 - National Electrical Code.

C. NFPA 701-99 - Fire Tests for Flame-Resistant Textiles and Films.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Submit Environmental Certification and Third Party Evaluation per Section 1.5 Qualifications.

C. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
   3. Storage and handling requirements and recommendations.
   4. Mounting details and installation methods.
   5. Typical wiring diagrams including integration of motor controllers with building management system, audiovisual and lighting control systems as applicable.

D. Shop Drawings: Prepare plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work.

E. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.

F. Selection Samples: For each finish product specified, one set of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.

G. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements. Shadecloth sample and aluminum finish sample as selected. Mark face of material to indicate interior faces.

H. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of ten years experience in manufacturing products comparable to those specified in this section.

B. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.

C. Fire-Test-Response Characteristics: Passes NFPA 701-99 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

D. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

E. Anti-Microbial Characteristics: 'No Growth' per ASTM G 21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

F. Environmental Certification: Submit written certification from the manufacturer, including third party evaluation, recycling characteristics, and perpetual use certification as specified below. Initial submittals, which do not include the Environmental Certification, below will be rejected. Materials that are simply 'PVC free' without identifying their inputs shall not qualify as meeting the intent of this specification and shall be rejected.

G. Third Party Evaluation: Provide documentation stating the shade cloth has undergone third party evaluation for all chemical inputs, down to a scale of 100 parts per million, that have been evaluated for human and environmental safety. Identify any and all inputs, which are known to be carcinogenic, mutagenic, teratogenic, reproductively toxic, or endocrine disrupting. Also identify items that are toxic to aquatic systems, contain heavy metals, or organohalogens. The material shall contain no inputs that are known problems to human or environmental health per the above major criteria, except for an input that is required to meet local fire codes.

H. Recycling Characteristics: Provide documentation that the shade cloth can and is part of a closed loop of perpetual use and not be required to be down cycled, incinerated or otherwise thrown away. Scrap material can be sent back to the mill for reprocessing and recycling into the same quality yarn and woven into new material, without down cycling. Certify that this process is currently underway and will be utilized for this project.

I. Perpetual Use Certification: Certify that at the end of the useful life of the shade cloth, that the material can be sent back to the manufacturer for recapture as part of a closed loop of perpetual use and that the material can and will be reconstituted into new yarn, for weaving into new shade cloth. Provide information on each shade band indicating that the shade band can be sent back to the manufacturer for this purpose.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in the Window Treatment Schedule.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.8 WARRANTY

A. Roller Shade Hardware, Chain and Shadecloth (except EcoVeil™): Manufacturer's standard non-depreciating twenty-five year limited warranty.
   1. EcoVeil standard non-depreciating 10-year limited warranty.

B. Roller Shade Motors and Motor Control Systems: Manufacturer's standard non-depreciating five-year warranty.

C. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: MechoShade Systems, Inc.; 42-03 35th Street, Long Island City, NY 11101. ASD. Tel: (718) 729-2020. Fax: (718) 729-2941. Email: info@mechoshade.com, www.mechoshade.com.
Interior Finishes, Local Rep., DCI Interiors, Maria Hawkins Phone (210) 521-9900 Fax (210) 521-9910 mariah@dcioffice.com

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of General Conditions.

2.2 APPLICATIONS/SCOPE

A. Roller Shade Schedule:
   1. Shade Type 1: Manual operating, chain drive, sunscreen roller shades in all exterior windows of rooms and spaces shown on the Drawings.
   2. Shade Type 2: Manual operating interior, chain drive room darkening roller shades with blackout fabric in all exterior windows of rooms and spaces shown on Drawings, and related mounting systems and accessories.
   3. Shade Type 3: Manual operating interior, chain drive "double" solar and room darkening blackout roller shades, operating independently of each other, in all exterior windows of rooms and spaces shown on Drawings, and related mounting systems and accessories.

2.3 SHADE CLOTH

A. Visually Transparent Single-Fabric Shadecloth: MechoShade Systems, Inc., ThermoVeil group, single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457

mm) diameter extruded vinyl yarn comprising of 21 percent polyester and 79 percent reinforced vinyl, in colors selected from manufacturer's available range.

1. Dense Vertical Weave: 2- 3 percent openness factor, #1004.
2. Dense Basket Weave: 5 percent openness factor, #1304.
3. Color: Black /Brown.

2.4 SHADE BAND

A. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem-pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.

1. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for all shades within one room.
2. Shade band and Shade Roller Attachment:
   a. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 inch (39.37 mm) in diameter for manual shades, and less than 2.55 inches (64.77 mm) for motorize shades are not acceptable.
   b. Provide for positive mechanical engagement with drive / brake mechanism.
   c. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on" snap-off" spline mounting, without having to remove shade roller from shade brackets.
   d. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
   e. Any method of attaching shade band to roller tube that requires the use of: adhesive, adhesive tapes, staples, and/or rivets are not acceptable.

2.5 SHADE FABRICATION

A. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb, unless specifically indicated otherwise.

B. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch (3.18 mm) in either direction per 8 feet (2438 mm) of shade height due to warp distortion or weave design. Fabricate hem as follows:

1. Bottom hem weights.
2. Concealed hemtube.
3. Exposed hemtube.
4. Exposed blackout hembar with light seal.
5. Exposed blackout hembar with polybond seal.

C. Provide battens in standard shades as required to assure proper tracking and uniform rolling of the shadebands. Contractor shall be responsible for assuring the width-to-height (W:H) ratios shall not exceed manufacturer's standards or, in absence of such standards, shall be responsible for establishing appropriate standards to assure proper tracking and rolling of the shadecloth within specified standards. Battens shall be roll-formed stainless steel or tempered steel, as required.

D. For railroaded shadebands, provide seams in railroaded multi-width shadebands as required to meet size requirements and in accordance with seam alignment as acceptable to Architect. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, assure proper use of seams or battens as required to, and assure the proper tracking of the railroaded multi-width shadebands.

E. Provide battens for railroaded shades when width-to-height (W:H) ratios meet or exceed manufacturer's standards. In absence of manufacturer's standards, be responsible for proper use and placement of battens to assure proper tracking and roll of shadebands.

F. Blackout shadebands, when used in side channels, shall have horizontally mounted, roll-formed stainless steel or tempered-steel battens not more than 3 feet (115 mm) on center extending fully into the side channels. Battens shall be concealed in a integrally-colored fabric to match the inside and outside colors of the shadeband, in accordance with manufacturer's published standards for spacing and requirements.
   1. Battens shall be roll formed of stainless steel or tempered steel and concave to match the contour of the roller tube.
   2. Batten pockets shall be self-colored fabric front and back RF welded into the shadecloth. A self-color opaque liner shall be provided front and back to eliminate any see through of the batten pocket that shall not exceed 1-1/2 inches (38.1 mm) high and be totally opaque. A see-through moiré effect, which occurs with multiple layers of transparent fabrics, shall not be acceptable.

2.6 COMPONENTS

A. Access and Material Requirements:
   1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
   2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
   3. Use only Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based plastics, and /or polyester, or reinforced polyester will not be acceptable.

B. Drive Chain: #10 qualified stainless steel chain rated to 90 lb. (41 kg) minimum breaking strength. Nickel plate chain shall not be accepted.

2.7 MOTOR CONTROL SYSTEMS (NOT USED)

2.8 ACCESSORIES

A. Roller Shade Pocket for recessed mounting in acoustical tile, or drywall ceilings as indicated on the Drawings – as required
   1. Provide either extruded aluminum and or formed steel shade pocket, sized to accommodate roller shades, with exposed extruded aluminum closure mount, tile support and removable closure panel to provide access to shades.
      a. Provide "Vented Pocket" such that there will be a minimum of four 1 inch (25.4 mm) diameter holes per foot allowing the solar gain to flow above the ceiling line.

B. Fascia – as required
   1. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
   2. Fascia shall be able to be installed across two or more shade bands in one piece.
   3. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
   4. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
   5. Notching of Fascia for manual chain shall not be acceptable.

C. Room Darkening Side and / or Sill Channels (for Shade 0900):
   1. Extruded aluminum with polybond edge seals and SnapLoc-mounting brackets and with concealed fastening. Exposed fasting is not acceptable. Channels shall accept one-piece exposed blackout hembar with vinyl seal to assure side light control and sill light control.

a. MechoShade side channels, 1-15/16 inches (49.2 mm) wide by 1-3/16 inches (30.1 mm) deep, two-band center channels, 2-5/8 inches (66.6 mm) wide by 1-3/16 inches (30.1 mm) deep. The 2-5/8-inch (66.6 mm) double-center channels may be installed at center-support positions of multi-band-shade ElectroShades. MechoShade side channels 2-5/8 inch (66.6 mm) may be used as center supports for ElectroShades; shadebands up to 8 high. For shadebands over 8 feet (2438 mm), provide ElectroShade side channels.
b. ElectroShade side channels, 2-1/2 inches (63.5 mm) wide by 1-3/16 inches (30.1 mm) deep; two-band center channels 5 inches (127 mm) wide by 1-3/16 inches (30.1 mm) deep. The 2-5/8-inch (66.6 mm) double-center channels may be installed at center-support positions of multi-band-shade ElectroShades. MechoShade side channels 2-5/8 inches (66.6 mm) may be used as center supports for ElectroShades. Also provide for use with manually operated room darkening MechoShades over 8 feet (2438 mm) in height.
c. Color: Selected from manufacturer's standard colors.
d. Color: Brown/ Black

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow proper clearances for window operation hardware.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

D. Engage Installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 12 24 13

SECTION 12 35 53 - LABORATORY CASEWORK, STAINLESS STEEL CABINETS

1.1 GENERAL

A. Description of Work
   1. This specification covers the furnishing and installation of materials for laboratory casework, stainless steel cabinets. Products shall be as follows or as approved by UT Health. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Assurance
   1. Comply with all provisions of specifications for the design, quality testing. Manufacturing and installation of metal kitchen cabinets and specified equipment.
   2. All kitchen cabinetry and equipment herein specified and shown on the drawings shall meet the standards, quality of materials, construction, workmanship and finish of Kewaunee Scientific.
   3. All metal cabinetry and equipment herein shall be the product of one manufacturer and be the one on which this specification is based.
   4. The manufacturer shall, from one year to date of installation, warrant parts or products manufactured and finished against manufacturing defects in material and any such parts which under normal use prove defective within one year form date of installation, shall be repaired or replaced without charge to UT Health.
   5. Wood shall not be used in any portion of the casework construction whether exposed or hidden from view. Except as detailed on the drawings.

C. Submittals
   1. Shop Drawings
      a. Identify location of metal cabinetry and related items.
      b. Detail cabinets, shelving, countertops, etc, in related and dimensional position, with sections. Locations for roughing-in of plumbing, including sinks, faucets, strainers, cocks, etc. shall be included
   2. Certificates: All bidders shall provide to The University independent test results from a nationally recognized testing laboratory on the finishes required for this project with the bid.

1.2 PRODUCTS

A. Material
   1. All metal cabinetry shall be fabricated to Type 304 stainless steel free of scales buckles or other defects.
   2. Minimum metal gauge: All minimum thickness of metal referred to herein shall be U.S. standard gauge.
      a. 20 Gauge: Inner door panels, inner and outer drawer panels, drawer body, and shelves.
      b. 18 Gauge: Outer door panels, sides, backs, bottoms, and tops.
      c. 16 Gauge: Top rails, cross rails, drawer slides.
      d. 14 Gauge: Leveling and corner gussets.

B. Fabrications
   1. Cabinet Grade: Premium and complying with the following.
      a. Align sides, top rails, bottoms and vertical stiles, at intersections, without overlap.
      b. Rounded edges.
      c. Full welded seams.
      d. Grind exposed welds flush and smooth.
   2. Cases: The sides of cabinets shall be formed to make a rabbeted stile 1-1/8” wide. Top of case stiles shall be closed by a mitered 45-degree bend from tip of case side. Stiles shall be closed by

welded channel, which contains front shelf adjustment louvers. All case members including intermediate cross rails shall be welded for maximum strength. Use of sheet metal screws to hold intermediate cross rails in place is not acceptable. Sides of all cabinets shall be free from any holes to prevent dust and bacteria from entering the cabinet. Pre-punched holes in the side of any cabinet will not be allowed. All drawer cabinets and cupboard cabinets shall have full backs and bottoms welded into place. Any cabinet without any backs or bottoms will be rejected. All interior bottoms of base and tall cabinets shall be turned down to provide a clean, flush interior free from dust catching ledges and preventing bacterial accumulation. Bottoms of all wall units shall be flushed; recessed bottoms are not acceptable.

3. Doors
   a. Doors shall be double panel reinforced construction 5/8” thick and sound deadened with vertical steel battens. Door fronts and liners shall be welded together for added strength. Door fronts and cases shall be slotted to receive hinges. Hinge wings must be concealed when doors open. Wrap around type hinges are not acceptable. All doors shall have soft rubber bumpers for quiet closing. Rubber bumpers must be securely locked in place. Rubber Bumpers attached by adhesives are not acceptable. All corners of doors shall be welded and ground smooth.
   b. Sliding doors shall be double panel reinforced construction 5/8” thick and operate on nylon rollers suspended from stainless steel track at top of unit and center guide at bottom. Sliding doors shall have recessed door pulls.
4. Drawers
   a. Drawers front shall be double panel reinforced construction with 5/8” thick fronts and sound deadened with vertical steel battens. Drawers shall be all welded construction. All drawers shall have soft rubber bumpers for quiet closing. Rubber bumpers must be securely locked in place. Rubber bumpers attached by adhesives are not acceptable. All edges of drawer fronts shall be closed.
   b. Drawer bodies shall be formed from a single sheet of steel including the bottom, two sides, back and inner front. Interior bottoms of drawers shall be fully covered on four sides for ease in cleaning. The top front of the inner drawer shall be offset to interlock with the outer drawer front.
   c. Flanges on the top of drawer body shall be fully formed channel and bent at a 6-degree angle for maximum strength. Flanges shall be formed to leave the inside of the drawer free form sharp edges. Drawer slide shall be welded to drawer body and be part of a “Z” shaped member in a wrap-around design to support drawer body. Drawer slides shall have a 15/16” nylon tired ball bearing roller. Drawer slide shall be roller type, positive in action permitting drawer to be fully opened; yet preventing drawer from accidental removal. Case slides shall be a formed piece of galvanized steel with 15/16” nylon tired ball bearing roller at front of slide. All ball bearing rollers for drawer slide and case slide shall be pre-lubricated to guarantee a smooth, quiet operation. All drawers shall rise upward when opened to prevent engaging of drawers and doors below. Drawers shall have self-closing design during the last 5” of travel.
5. Shelves: Shelves shall be formed from a single sheet of stainless steel with 7/8” face turned back and up at a 30-degree angle and edge of flange shall make firm contact with underside of shelf for sound deadening. All shelves in cabinets shall be adjustable on 1-1/2” center and supported by stainless steel clips placed in embossed louvers. All shelves shall be solid.
6. Hardware: Door catch shall be positive type latch located at upper inside edge of door. Stainless steel strike bracket shall be installed inside of door with accessible removable screws. Bolt shall be nylon self-closing type tested for 300,000 opening and closing cycles. Complete bolt housing shall be recessed behind cross rail. Roller catches and/or friction catches are not acceptable.
7. Hinges: Hinges shall be institutional type, 2-1/2” long, with a metal thickness of least 0.090”, containing 5-knuckles, and centered 3” above bottom and below top of door. Doors 45” high and over shall have an additional hinge in center. Hinges shall be stainless steel with smooth rounded joints for easy cleaning. When door is closed, only the joint shall be exposed. Both hinge wings

shall be encased, one within the door, the other within the case. Hinges shall be attached to the door and the case by screws. Hinges welded to door and/or case are not acceptable.

8. Door and Drawer Pull: Door and drawer pull shall be stainless steel with a brushed satin finish. Shoulder screws shall be used so that when handles are mounted they do not cause the door to buckle or cave. Sliding doors shall have recessed door pulls.
9. Base Cabinet Legs: All base cabinets and sink units shall be furnished with integral stainless steel legs with adjustable levelers. Bottom of base cabinets shall be approximately 6” above the floor.
10. Locking Mechanism: All cabinet doors shall be provided with stainless steel angle hasps, with half-inch diameter holes for pad locking, as shown on the drawings. The left door of each door pair shall have a sliding flush bolt on the inside face, as shown on the drawings, to prevent the pair of doors from swinging open when pad locked.

C. Steel Cabinet Finish
   1. Test Procedure: Chemical spot tests shall be made by applying 10 to 15 drops (approximately 0.5 cubic cm) of each reagent listed in Table 1 to the surface to be tested. Each reagent spot shall be open to the atmosphere. Ambient temperature is 68-72 degrees F (20-22 degrees C). After one hour, chemicals shall be flushed away with cold water and the surface, washed with detergent and warm water at 150 degrees F (65 degrees C). Surface shall be examined under 100-foot candles of illumination.

D. Laboratory Cabinets Performance Requirements
   1. Base Cabinets.
      a. Cabinets Load Test: A 48” wide standing height combination cupboard and drawer cabinet shall be freestanding with installed counter top. Cabinet shall sit 1” off the floor on all four leveling screws and be capable of supporting a uniform distributed load of 2,000 lbs. Door and drawer operation shall not be affected by the load.
      b. Leveling device for floor mounted cabinets shall be capable of supporting a load of 500 lbs. Without failure and capable of adjustment after load is removed.
      c. Cabinet Door Test: An open door shall withstand a load of 200 lbs. applied directly at the outer edge. Door shall be moved through a 180 degree arc and weight removed. Operation of the door after test shall be normal without distortion that will adversely affect operation for the door catch.
      d. Life Cycle Test.
         1) Door hinge shall operate for 300,000 opening and closing cycles without a failure.
         2) Positive door catch shall operate for 300,000 opening and closing cycles without failure.
         3) Drawer shall be tested and operated with a load of 100 lbs. for a minimum of 150,000 opening and closing cycles. After test, drawers shall operate freely without evidence of dragging or scraping.
   2. Wall Cabinets
      a. A 48” wide, 30” high, 12 ¾” deep hinged wall case shall support a load of 1lbs. on cabinet bottom and 100 lbs. on each adjustable shelf for a total of 300 lbs. Cabinet shall not show any significant permanent defection of cabinet, cabinet bottom or shelves. Doors shall operate smoothly when cabinet is fully loaded.
      b. An adjustable shelf shall support a uniformly distributed load of 100 lbs. When load is removed, shelf should show no significant permanent distortion.
      c. Performance of hinge and catch shall be the same as used on base cabinets.

E. Working Surfaces
   1. Stainless Steel: Sink and counter tops shall be fabricated of 16 gauge, Type 304, 18-8 solid stainless steel formed down and back making a 1 ½” high face on all exposed edges. Drainboards and cabinet tops shall be rigidly reinforced the full length of the top. Drainboards shall be two-way pitched to the bowl to provide drainage without channeling or grooving. Drainboards, flanges and splashes shall be integral, being formed from one sheet of metal. Raised edge surrounding unit shall be seamless die formed at front and ends of unit. Sink bowls shall be fabricated of 16 gauge,

Type 304, 18-8 solid stainless steel seamless electrically welded to drainboard. All joints shall be electrically welded, ground and polished to a satin finish. Entire units shall be thoroughly sound deadened on under surface with sprayed or troweled undercoating. Wood shall not be used. All tops shall have stainless steel runners to facilitate fastening to cabinets.

1.3 EXECUTION

A. Insulations

1. Install cabinets, shelves, counter tops and other equipment level and square. Install sink units to provide positive drainage of bottom surface of the sinks.
2. Wall cabinets shall be hung from the metal stud framing system wherever possible. If the wall cabinets must be hung from the wall surfacing at any location, proper anchors shall be used. Install wall cabinets level and aligned.
3. Install base cabinets firmly on ground. Level all the surfaces by adjusting the leg levelers. Attached countertops to installed base cabinets with stainless steel screws as required. Caulk with silicone all around counter tops where it interfaces with the existing walls. Install the flat back panels to the wall surfaces by the most appropriate method and caulk as required.

B. Inspection

1. Inspect installed work of other trades and installation conditions for acceptability. Inform Owner of discrepancies that will jeopardize a complete and proper installation
2. Cleaning: Touching up marred and/or abraded finished surfaces, clean components to post construction accepted levels, remove crating and packing material, broom sweep premises.

END OF SECTION 12 35 53

SECTION 12 36 61 16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01.1.1.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.01.1.1.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: All work of this section shall be fabricated and installed by a fabrication professional who has been accredited by the manufacturer of the solid surfacing materials. The fabricator shall be skilled in the knowledge and ability required to provide work in accordance with the manufacturer's "Fabrication and Installation Manual" and shall have a minimum of five (5) years of fabrication experience and shall have completed a minimum of five (5) fabrication projects of similar scope and size to the fabrication and installation work of this Project.

1.01.1.1.3 Source Quality Control: Obtain and provide materials from a single manufacturer of solid surfacing materials with not less than five (5) years of successful experience in supplying principal materials. Provide secondary and alternate materials only as recommended by the manufacturer of the primary materials.

B. Wherever possible, check dimensions of supporting structure at the Project Site by accurate field measurements before final submittal of shop drawings and fabrication of stone. Where necessary, proceed without field measurements and coordinate installation tolerances to ensure proper fit of stonework.

1.4 SUBMITTALS

A. Samples:

1. Samples for initial selection purposes in form of manufacturer's color charts consisting of actual pieces or sections of pieces showing full range of colors and patterns available for each type of solid surfacing material indicated.

2. Samples for Verification Purposes: Submit three sets not less than 4 inches by 4 inches in size, of color, grade, and finish of each type of solid surfacing material required. Include the full range of exposed color and texture to be expected in the completed work. Architect’s review will be for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

B. Shop Drawings:

1. Submit cutting and setting drawings showing sizes, dimensions, sections, and profiles of solid surfacing material units, the arrangement, and provisions for jointing and other necessary details for reception of other work.

2. Submit drawings for the fabrication and installation of countertops with integral bowls. Indicate dimensions, size, and location of cutouts, and relation to plumbing work.

1.01.1.1.3.1 DELIVERY, STORAGE and HANDLING

C. Protect solid surfacing material from damage during loading, shipment, delivery, and storage. Use non staining materials for blocking and packing. Stack and block solid surfacing material units at the Project Site in accordance with fabricator's recommendations.

1.5 WARRANTY

A. Solid Surfacing Material Fabrication and Installation:

1. Provide manufacturer's standard ten (10) year limited warranty. The manufacturer shall warrant that the materials provided under this Section shall not develop visible defects of otherwise fail due to manufacturing defects within a period of ten (10) years from the date of Substantial Completion of the Work.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 manufacturers

A. The notes and schedules on the Drawings establish manufacturer and model/design required for the Project. Provide the products listed unless Architect approves products of other manufacturer specifically for this Project.

2.3 MATERIALS

A. Solid surfacing material shall be composed of a homogeneous mixture of thermoset polymer, cast with an acrylic or polyester resin into a hard, durable, polished unit.

1. "Wilsonart Engineered Surfaces"

2. or approved equal

1.01.1.1.3.2 SOLID SURFACING MATERIAL SCHEDULE

B. Provide solid surfacing materials in color and finish scheduled below:

1. "Wilsonart Engineered Surfaces"

2. or approved equal

1.01.1.1.3.3 FABRICATION

C. **Fabrication shall be performed by a fabricator, accredited by the manufacturer**, in accordance with manufacture's recommendations and reference manuals.

1.01.1.1.4 Shop fabricate components to greatest extent practicable to size and shapes indicated, in accordance with approved shop drawings.

D. Comply with the manufacturer's recommendations for the use of specific types of stationary equipment and stationary tools. Site fabrication and finishing processes shall be in accordance with the manufacturer's recommendations.

1.01.1.1.5 Form seams between components, unless otherwise indicated, using manufacturer's standard structural adhesive. Adhesive shall be color coordinated to match solid surfacing material color and shall form inconspicuous seams. Seams shall not be permitted along the long side of any areas of less than 36 inches across.

E. Provide factory cutouts for plumbing fittings and bath accessories as indicated on the drawings and as recommended by the solid surfacing manufacturer.

1.01.1.1.6 Cut and finish component edges with clean sharp returns. Rout radii and contours to exact template sizes. Repair or reject defective or inaccurate work.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

1.01.1.1.7 All installation shall be in accordance with manufacturer’s published recommendations.

B. Prepare substrate plane, plumb and level, secure in place with all fasteners set flush. Shim supporting structure as required to provide and acceptable surface for attaching finish materials.

1.01.1.1.8 Install components plane, plumb and level, in accordance with approved shop drawings and product data.

C. Pre-fit finish material in place. Scribe material as required to provide proper fit with adjacent materials.

1.01.1.1.9 Provide additional support for material seams in both horizontal and vertical locations. Separation/release paper shall be provided between all supports and seams to prevent direct adhering of finish material to substrate.

D. Form field joints using manufacturer's recommended adhesive, with inconspicuous joints in finished work.

1.01.1.1.10 Prior to installing fabrications, make sure that substrate is clean and dry. Place silicone "dads" on substrate in accordance with manufacturer's recommendations.

3.2 CLEANING

A. At Substantial Completion remove temporary protection and thoroughly clean work.

1.01.1.1.11 Do not use wire brushes, acids, abrasive cleansers, or solutions which might cause discoloration or abrasion.

B. Clean by scrubbing with a soft cloth using liquid detergents as recommended by the manufacturer and water. Rinse with clear water. Repoint joints where necessary.

END OF SECTION 12 36 61 16

SECTION 13 00 00 00 - SMALL ANIMAL(RODENT) VIVARIUM, CONSTRUCTION STANDARD

Table of Contents

1. Introduction - Not Used

2. Piping Systems

2.1 General

A. Introduction and Background

Piping supply services may include, but not be limited to, the following:

- Domestic Hot and Cold Water • Liquid Nitrogen
- Reverse Osmosis Water System* • Fire Protection Systems
- Compressed Air* • Sanitary Waste and Vent
- Specialty Gases* (Oxygen, Carbon Dioxide, etc.) • Storm Sewer
- Vacuum* • Site Utilities
- Natural Gas*

**In many cases point-of-use equipment will meet need. A/E Team to discuss with Owner.*

B. Data

1. Plumbing systems design shall be performed by individual(s) certified in Plumbing Engineering /Design (C.I.P.E or C.P.D.) by the American Society of Plumbing Engineers or by a Texas licensed professional engineer having minimum five years' experience designing the types of plumbing systems included within this project.

2. The design team is required to make themselves aware of all applicable codes and ordinances and assure compliance thereto.

3. Where provisions for future equipment, fixtures or building expansion are required, systems equipment capacity, pipe sizing and arrangement shall accommodate proposed future demand.

4. To preclude congestion of commodities within the interstitial space located above the vivarium, the A/E team shall discuss space allocation for each of the disciplines, which include mechanical, electrical, plumbing, and controls. Each of the disciplines shall have an assigned area and/or elevation designated as their design space. When one discipline has to enter or pass through a space assigned to another discipline, they shall interface to assure access to perform maintenance on the device is possible.

5. While in many cases piping material is identified in the following sections, the NE Team should refer to the most current UT Health Master Specifications for final material selection.

C. Standard

1. The piping distribution systems, with the exception of liquid nitrogen, are anticipated to be routed on a common trapeze pipe rack located in the interstitial space to provide horizontal distribution to vivarium rooms and support areas.

2. Liquid nitrogen will be supported by a dedicated hanger or riser with limited horizontal distribution.

3. Building fire protection will occupy a separate routing coordinated with other utilities.

4. Upper levels of sanitary waste, lab waste, and storm drain systems will be gravity flow systems. Basement areas will require a pumping system to a level that the systems can discharge into gravity systems.

5. Where applicable, all services will utilize chases within the building footprint for vertical routing to multiple floor levels.

6. Piping distribution systems and primary equipment will be sized using a diversity factor determined for each system based on programming.

7. Where possible, piping distribution systems should not be routed above vivarium animal holding spaces to avoid possible flooding and water damage to animals housed below the piping.

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design

Criteria D-16, 17 and 18.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

2.2 System Descriptions

2.2.1 Domestic Hot and Cold Water

A. Introduction

1. Domestic hot and cold water will be provided for all toilet rooms, emergency shower/eyewash units, all lab and vivarium areas and all other devices that require a domestic water supply. Water will also be required for process water, trap filler water, soft water and mechanical water.

2. A domestic water booster pump system will elevate the incoming water pressure to adequate levels to serve upper floors as required. Lower floors will be protected from overpressure conditions by pressure reducing valves.

3. Steam-to-water, single wall, semi-instantaneous water heaters in parallel will produce hot water for all building needs. Water heaters will be supplied with steam to the coils and have water on the shell side. Point of use booster heaters will be employed at equipment such as cage and rack washers, glass washers, and laundry facilities to address special temperature needs.

4. All hot water will be softened. Softeners will normally be duplex, automatic regeneration type. Softening equipment will also serve the animal watering RO system.

B. Background

1. Separate heaters and distribution systems shall be employed to provide process hot water to equipment such as cage and rack washers, glass washers, and other equipment as required to address special temperature needs. Water heating equipment and distribution systems shall be designed to provide the required temperature and quantity of hot water at all times.

2. Animal watering shall utilize reverse osmosis water from a dedicated system and shall be furnished as part of the packaged automated animal watering system. The animal watering system shall be designed and sized to provide a three day supply of purified water in the event there is an interruption of the facility's main incoming domestic water service.

C. Standard

1. Potable water will be supplied from the city main service line. Water will be piped to plumbing fixtures which include water closets, urinals, lavatories, lab sinks, sinks in fume hoods and all other equipment and fixtures which require water. After entering the building, the water service will be split into two systems, one system will be potable water for the public areas and the other system will be for the vivarium areas. The city main will be protected against contamination with the installation of a double check valve assembly on the incoming water service. The building water system will be protected from the vivarium water system with a double reduced pressure backflow preventer (if a booster pump is required the reduced pressure backflow preventer will be installed after the booster pump assembly).

2. The system will be designed to maintain a maximum velocity of eight fps in mains and risers, six fps in branches at design flow conditions.

3. The system will be designed to prevent water hammer conditions by providing shock arrestors for quick closing valves, individual fixtures and batteries of fixtures.

4 Piping will be sized to maintain a minimum of 30 psi at the most remote flush valve and 8 psi at the most remote lavatory faucet.

5. Shut-off valves will be provided at branch connections.

6. Vacuum breakers will be provided at hot and cold water hose stations and laboratory faucets.

7. A triplex booster pump will be provided (if required) to elevate the incoming water pressure so it may

reach the upper floors with adequate pressure. The pumps will be set up for a lead lag-lag operation with a split as designed by the A/E team. The size of the pumps will be determined by the estimated load of the building. Variable speed drive pumps will be used for low flow conditions.

8. Hot water will be generated from a single or multiple (depending on the load requirements) semi-instantaneous water heaters. The heater(s) temperature will be set at 120°F. The water temperature will be maintained throughout the system by the use of a re-circulation system or hot water temperature maintenance system.

9. Domestic hot water temperature shall not exceed 110 degrees F at faucet and shower outlets.

10. Incoming water service will be ductile iron pressure pipe, class 52, bituminous coated outside, push-on type joints with molded rubber compression gaskets. The lining of the piping will be cement mortar or fusion-bonded epoxy or ceramic epoxy. Fittings will be mechanical joint, ductile iron, bituminous coated outside.

11. Hot and cold water (potable and laboratory) piping 2 inch and smaller will be Type K soft annealed seamless copper tubing with wrought copper solder fittings. Joints to be applied with grade HB lead-free solder.

12. Hot and cold water (potable and laboratory) piping 3 inch and larger will be Type L hard drawn seamless copper tubing with wrought copper or cast bronze, grooved ends fittings. Joints will be rolled groove with ductile iron with copper color alkyd enamel paint coating and synthetic rubber, grade E EPDM gaskets, flush seal design, conforming to the copper tube sizes.

13. All piping, components subject to sweating, heat loss or freezing will be insulated with appropriate thickness of fiberglass insulation with a fire-resistant jacket.

14. All piping in accessible areas will be indicated with system and direction of flow through color coded labels.

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-16, 17 and 18.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

2.2.2 Reverse Osmosis Water

A. Introduction

There may be several needs for pure water supply in a small animal vivarium. Some of the experimental research may need pure water supply in procedure room laboratory benches/sinks. In addition, the animal watering system is also assumed to need a pure water supply for animal hydration. The animal watering system requirements will be addressed in a separate design standard covered by Section 3.2.9, Mechanical Systems, System Descriptions, Animal Watering.

B. Background

The primary source of water conies from a state-approved domestic source such as a municipal water system. Even though approved for domestic consumption, the water quality from these sources could vary widely in trace mineral content and not be pure enough for use in wet lab experiments or for animal watering.

The National Research Council (NRC) Guide indicates animals should have access to potable, uncontaminated drinking water. Also, water quality and the definition of potable water can vary with locality. Periodic monitoring for pH, hardness and microbial or chemical contamination may be necessary to insure water quality is acceptable. Water can be treated or purified to minimize or eliminate contamination when protocols require highly purified water. The selection of water treatments should be carefully considered because many forms of water treatment have the potential to cause physiologic alterations or effects on experimental results.

In most UT HEALTH applications, the domestic/potable water quality will require both water softening to reduce mineral hardness and then further water purification, usually by reverse osmosis (RO) to provide water of the required level of purity for laboratory research and animal watering use.

Special attention should also be placed upon the high purity water distribution system piping connections and integrity.

Depending on the actual applications, the pure water requirements in laboratory space may be better met through commercial point-of-use generators thereby reducing the need for extensive piping distribution systems. In large vivarium applications, the central water treatment/RO system is probably the correct application to supply animal watering needs via a piping distribution system.

C. Data

1. Provide water softener systems to reduce hardness as required to supply water heating equipment, pure water production equipment, and other systems, fixtures and equipment which hard water may adversely affect operation or longevity. Water with a hardness of more than two grains per gallon shall not be delivered to equipment requiring softened water.

2. The facility may be equipped with a high purity water system to serve laboratory needs and other building demands requiring a pure water source. CAP type II water will be produced to meet a resistivity of 1.0 megohm/cm, and supplied to all programmed outlets. Point-of-use polishers will be utilized where higher purity is required by individual users.

3. Dedicated pure water equipment will include a multimedia filter, activated carbon chlorine removal, and double pass, staged reject reverse osmosis generator. Additional primary equipment will be evaluated based on supply water chemistry analysis and product water needs. The system will be with soft water from the buildings duplex water softener system supplied.

4. Ultra-violet lights will be used to control bio-burden build-up in the circulation system. The animal watering system will utilize RO feedwater from the central RO system.

5. A separate RO water storage tank will be located near in the vivarium to provide water to the animal drinking water system. The RO water shall be chlorinated prior to filling the vivarium drinking water storage tank. The vivarium storage tank will be sized to provide a three-day supply of water.

6. Each point of use valve will be looped no greater than 6 pipe diameters from the loop to minimize the length of dead legs.

7. Each loop will be hydraulically designed with fabrication drawings being required of the Contractor to document the system installation as designed.

8. The distribution piping system from the RO system to the animal watering system will be natural, unpigmented polypropylene pipe and socket fittings with socket fusion joints. Provisions will be made in the project specifications to allow for joint sampling to ensure fabrication performance and joint uniformity.

9. High purity water will be continuously circulated in loops at 5.0 FPS velocity minimum.

10. Each outlet will be assigned a use value of 10 liters per day with an average flow rate of 1 GPM. Equipment loads will use actual manufacturer's consumption loads. All loads will be totaled, a diversity factor applied, and the primary equipment sized to provide that volume over a 12-hour period.

11. The main storage tank, located in the mechanical room, will be sized to store 4 hours of peak consumption rate, plus pipe volume, plus freeboard.

D. Standard

High Purity Water System

Water softener required	Supply water hardness will usually require for vivarium and procedure use.
Water quality required	CAP type II, 1.0 megohm/cm
Central System vs. Point of Use?	Point of Use generators of high purity water preferred for laboratory applications. Central system probably required for supply to animal watering system.
RO water requires recirculation	Yes, at 5 fps minimum flow. Recirculating RO water should be treated by ultra-violet lights.
RO water distribution piping	Natural, unpigmented polypropylene pipe and socket fusion joints. Fusion process must be reviewed and approved by owner before allowed on job.
Dead legs	Minimize to within 6 pipe diameters.
Capacity	Use diversity among outlets to reduce storage.

E. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2, page 40.
Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

2.2.3 Compressed Air

A. Introduction

Compressed air for the vivarium areas, autoclave areas, as a source for temperature control air, and for main risers will be provided at 100 psig, regulated as required, and dried to 35° F pressure dewpoint. Distribution run-outs to lab floors, will be as required for autoclaves, etc. Vendor shall analysis and advise if different than listed.

B. Standard

1. Production Equipment

a. Air compressors will be oil-free, scroll type machines, air-cooled, in a duplex configuration. Each compressor will be sized to meet 100% of full load conditions. An alternator will rotate each compressor through the lead position to give equal run time to each machine.

b. Air dryers will be refrigerated type to dry the air to 35° F pressure dewpoint. Two dryer units will be provided, each capable of 100% air load.

c. Coalescing and particulate filters will be provided after each compressor.

d. Particle filters will be provided downstream of the dryers. Filters will be in parallel with pressure indicators, sized for 100% of systems flow. Particle size of filtration will be 0.1 micron absolute.

e. The air compressors will be sized by totaling the CFM required per outlet and using a diversity factor based on the total number of outlets. An air receiver will be provided to absorb heavy system intermittent demand.

f. Mains and risers will be sized for distribution at 100 psig.

2. Distribution System

a. The compressed air piping system will be Type L copper tube and fittings with 95-5 lead free solder joints. Branches will be taken off the top of the mains and the piping will be pitched for drainage. The distribution system will be sized so that the uniform friction loss does not exceed 10% of the delivered pressure and the velocity does not exceed 4000 feet per minute.

3. Design Criteria

a. Lab outlets will be assigned a flow value of 1 CFM per outlet. A diversity factor will be applied based on the total number of outlets. Other equipment requiring a compressed air supply will utilize manufacturer's data.

C. References

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

2.2.4 Special Gases, 02 and CO2

A. Introduction

1. Special gases will be determined based on the laboratory and vivarium program.
2. Special gases will be supplied from a bottled manifold system located near the lab or in a location selected at design.
3. Each outlet will be assigned a value of 1 standard cubic foot per minute (SCFM) The system will be sized based on the total of all the outlets.
4. Piping will be stainless steel or piping appropriate for the type of gases required.
5. After the piping has been installed it will be purged internally with clean dry compressed air of sufficient quantity that will dislodge sediment or dirt.

B. Background

In addition to the special, unidentified gases noted above, this design standard section will also cover the use of specific gases to include oxygen (O2) and carbon dioxide (CO2).

C. Standard

1. Oxygen

a. Gaseous oxygen for the procedure rooms will be provided at a pressure of 50 pounds per square inch gauge (psig) at the most remote outlet.

b. Oxygen source will be from a cylinder room or similar area with distribution to the required point of use.

c. The system piping will be sized by totaling the CFM required per outlet and using a diversity factor based on the total number of outlets.

d. The oxygen piping system will be Type K copper tube and fittings pre-cleaned and capped for oxygen service per NFPA 99 and ASTM 819 with brazed joints. The distribution system will be sized so that the uniform friction loss does not exceed 10% of the delivered pressure and the velocity does not exceed 4000 feet per minute.

e. Outlets will be assigned a flow value of 1 CFM per outlet. A diversity factor will be applied based on the total number of outlets.

f. O2 manifolds will have automatic cylinder changeover.

g. 4 inch and smaller use Type L hard drawn seamless copper tubing, factory oxygen cleaned, nitrogenized, capped and bagged.

h. The fittings will be wrought copper, solder cup ends, factory oxygen cleaned, nitrogenized, capped and bagged.

i. The joints to be brazed with alloy classification BCuP5, with continuous nitrogen gas purge.

2. Carbon Dioxide CO_2

a. Carbon dioxide will come from a bottled manifold system located near the lab or in a location selected at design.

b. CO2 will be provided for any procedure rooms and other areas determined by the program.

c. Carbon dioxide will be distributed to all areas programmed in Type K copper tube and fittings pre-cleaned and capped for oxygen service NFPA 99 and ASTM B819 with brazed joints.

d. Underground piping will be Type K copper tubing oxygen pre-cleaned and capped per NFPA 99 and ASTM B819 with brazed joints.

e. Carbon dioxide piping will be sized at 1 CFM per outlet, the flow totaled, and a diversity factor applied based on the total number of outlets. Incubators will be assigned a use flow of 5 CFM.

f. After the piping has been installed it will be cleaned by blowing dry oil-free nitrogen gas.

D. References

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

NFPA 99

ASTM

2.2.5 Laboratory Vacuum

A. Introduction
The need for a central vacuum system in a small animal vivarium will be based upon the type of research conducted in the procedure rooms, surgery suites, imaging areas and necropsy rooms. The final vivarium facility program will determine the need, if any, for a central vacuum system in the facility.

B. Background
If the program requires a central vacuum system, the requirements in the following sections should be followed.

C. Data

1. The A/E team shall develop plans, schematic diagrams, schedules and details indicating all information required to clearly illustrate the intent of system design.

2. Floor plans shall include, but not be limited to location, sizes and identification of all: piping from source equipment or existing piping connections to terminals; intake and exhaust piping from source equipment to termination through roof or connection to existing piping; master and local alarm panels; alarm sensors; pressure gauges; relief valves; relief valve discharge terminals; zone valve wall cabinets; in-line shut-off and service valves; future valved

connections; source equipment; inlets, outlets and slides. Schematic diagrams shall include, but not be limited to identification and sizes of all of the above information.

3. NFPA 99 guidance should be followed, as appropriate, for the design of a central vacuum system.

D. Standard

1. If required, the central laboratory vacuum system at 19" Hg (Mercury) gauge at the most remote laboratory inlet will be provided to serve all lab, fume hood, and bio-safety cabinet vacuum inlets.

2. Lab vacuum will be produced by a packaged duplex rotary screw vacuum pump system with receiver and automatic controls. Each vacuum pump will be sized for 100% of full load. An alternator will rotate each machine through the lead position to give each unit equal run time. A vacuum receiver will be installed to allow any liquids or solids introduced into the piping to be contained.

3. The lab vacuum piping system will be Type L copper pipe and wrought copper fittings with 95-5 lead-free solder joints. The distribution system will be sized so line velocities do not exceed 5000 feet per minute and total friction loss does not exceed 3.5" Hg. Vacuum exhaust piping will discharge to atmosphere and utilize Type CPVC pipe and fittings.

4. Each vacuum inlet will be assigned a load value of 0.5 standard cubic feet per minute (SCFM). The total flow will be calculated by totaling all the inlets and applying an appropriate diversity factor. In-line vacuum filters will be provided on each BSL2 and BSL3 inlet, bio-safety cabinet inlet, and other inlets as programmed.

5. Locate medical air compressors and vacuum pumps in a dedicated mechanical room in accordance with NFPA 99. Mechanical room shall provide a clean, relatively cool environment (i.e., not to exceed 100 degrees F ambient temperature). Equipment shall be located with adequate access space for regular monitoring and servicing. Provide floor drain adjacent to equipment pads. Floor drains serving vacuum pumps shall be provided with smooth, acid resistant interior coating. Provide a hose bib within mechanical room.

6. Terminate medical vacuum exhaust discharge outdoors above roof level, at least 25 feet horizontally (may be more depending upon prevailing wind direction and velocity) from all air intakes, doors, windows, louvers or any other building openings. Combine exhaust from each vacuum pump into one discharge pipe, sized for no restriction while flowing maximum discharge possible, and shall be provide with an isolation valve at the header for each pump served. Exhaust piping for vacuum pumps shall be sized using the total scfm for the system (both lead and lag pumps) and the total developed length of run. Exhaust piping shall be sized and arranged to prevent moisture and back-pressure from entering pump. Provide valved drip- leg at base of exhaust stacks. Coordinate with vacuum pump system technical representative and verify that proposed sizing of exhaust piping complies with manufacturer's recommendations.

7. Place a source shut-off valve for each vacuum and gas system at the immediate outlet (or inlet, in the case of vacuum) of the source of supply, so that the entire supply source, including all accessory equipment, can be isolated from the entire pipeline system. Provide each main line supply line with a shut-off valve. Locate valve accessible by authorized personnel only and locate downstream of the source valve and outside of the source room, enclosure, or where the main valve enters the building. Provide medical vacuum and gas services with line pressure and vacuum gauges at the source (and immediately inside the building, where source is remote from building).

E. References

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

UT HEALTH Design Guidelines. South Campus Vivarium Project 04-0032. April 11, 2005.

2.2.6 Natural Gas

A. Introduction

A small animal vivarium will have the need for cage washing and sterilization. This process is usually done through the use of clean steam which may be produced by steam boilers or clean steam generators. The normal fuel for steam or hot water boilers is natural gas and the piping requirements for that energy source will be addressed in this section.

B. Data

All natural gas piping on the customer side of the utility meter shall be designed, installed and tested in accordance with NFPA 54, Fuel Gas Code.

C. Standard

When natural gas is required in the vivarium to support steam generation for cage cleaning and sterilization, the following requirements should be met:

1. All piping and valves shall be located and sized on drawings.
2. The A/E team shall include a natural gas system distribution schematic indicating information required to clearly illustrate the intent of system design including, but not limited to, supply source, piping mains, risers, pressure regulating valves, all shut-off valves, branch and individual connection piping to equipment and outlets. Calculated flow rates and developed piping lengths used for system design shall be noted at supply entrance, base of risers, sectional floor valves, branch piping to equipment and outlets, and at each connection to equipment and outlets.
3. The A/E team shall include details on contract drawings to clearly identify installation requirements for all natural gas system components included within the project, including but not limited to; service entrance, gas fired equipment connections, emergency shut-off valves, laboratory zone valves, pressure regulator venting, concealed pipe casing venting termination, roof penetrations, floor and wall penetrations.
4. The NE shall include schedules on contract drawings to clearly identify natural gas system demand, pressures and equipment served.
5. Building natural gas distribution systems shall be metered and valved in accordance with the gas suppliers requirements.
6. The design of building supply and distribution systems shall provide a volume of gas at the required flows and pressures to ensure safe, efficient and code compliant operation during periods of peak demand. Piping shall be sized in accordance with referenced codes and standards.
7. Natural gas pressures shall not exceed five pounds per square inch gauge on customer side of the meter.
8. Provide readily accessible manual shut-off valve outside of building at service entrance.
9. Avoid locating gas piping within confined or unventilated spaces where leaking gas might collect.
10. Do not locate gas piping beneath building slab on grade. Do not locate gas piping within stairways, electrical or telecommunications rooms.
11. Main distribution piping risers shall be located exposed within mechanical equipment rooms where possible. Where distribution mains cannot be located within mechanical equipment rooms, utilize chases within the building footprint. Natural gas piping installed above ceilings, within chases, within partitions, within spaces utilized as return air plenums, or any non- exposed location shall be encased within a sleeve vented to the exterior of the building.
12. Exposed and accessible shut-off valves shall be provided as required for proper operation, servicing and troubleshooting of the distribution system and connected components. Locations shall include but not be limited to the following; at the base of each riser, at each branch connection to risers, at each piece of equipment, where recommended by equipment manufacturer and at strategic locations to allow sectional isolation while limiting disruption of services to large portions of the system.
13. Exposed and accessible capped valves shall be provided where required for future connections.

14. Valves, regulators, flanges, unions and similar appurtenances shall be accessible for operation and servicing and not be located above ceilings, within partitions or spaces utilized as return air plenums.

15. No natural gas line, including service drops shall be smaller than Y inside diameter. Local connections to

individual equipment and outlets may be smaller than ^{3}t," as required for the particular component.

16. Natural gas piping will be Schedule 40 black steel pipe and fittings with welded joints up to the emergency shut off valves. Valves will have screwed or flanged ends. An emergency electric power shut off control will be located at lab exits. Operation of this control will close the emergency gas shut off valve and interrupt natural gas flow to the entire floor.

17. Natural gas piping will be sized at 5 CFH per outlet, the flow totaled, and a diversity factor applied based on the total number of outlets.

D. References

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

NFPA 45, Fuel Gas Code.

2.2.7 Liquid Nitrogen

A. Introduction

Liquid nitrogen (LN2) temperature is -320 degrees Fahrenheit. Nitrogen expands 700 times from liquid to gaseous state. These unique characteristics of LN2 provide for specific applications in refrigeration and also require unusual design attention for specific applications. Relative to applications in a small animal vivarium, LN2 could be used for cryo-biological freezing and storage of tissue samples.

B. Background

Because of LN2's low temperature, special piping and insulation requirements must be considered in the design of distribution piping and spaces that will house LN2 freezers or storage equipment.

C. Data

1. LN2 process piping must conform to the requirements of ASME B31.3 Process Piping Code.
2. Normal pressure rating for LN2 piping is 150 psig with normal applications requiring operating pressures of 20-70 psig (pounds per square inch gauge).

D. Standard

1. A liquid nitrogen supply system will be provided for LN2 freezers in the segregated freezer rooms. The liquid nitrogen source will be from an exterior bulk liquid nitrogen storage tank.

2. In these freezer rooms, liquid nitrogen will be piped to the freezers through a piping system from the exterior bulk system. Oxygen O_2 depletion monitors will be placed in the freezer rooms. These monitors will be connected to the BAS system and alarm when LN2 leaks into the freezer room.

3. Pipe runs will be minimized to limit loss of product. Distribution piping will be vacuum insulated 304 stainless steel liquid nitrogen piping. The piping will be double wall with the inner space vacuum sealed at the factory to minimize gas conduction and convection. Multi-layer super insulation minimizes radiation and will be sandwiched between the double pipe walls.

4. Super insulation consists of multiple layers of cryogenic grade spacer paper and aluminum foil or double aluminized Mylar.

5. All carrier piping will be schedule 5, type 304 stainless steel (SS) or Invar with all interior connections welded. SS bellows are required between the inner and outer jacket to account for differential shrinkage due to temperature gradient.

6. Vacuum jacketed piping will normally be custom fabricated at the factory with 20 foot sections optimal for manufacturing and shipping.

7. Vacuum jacketed LN2 piping sections are usually joined by way of bayonet type connections in the field.

8. Pipe routing will be designed such as to minimize field connections. Pressure relief valves will be required in

any spot where liquid can be trapped. Pipe should be supported by hangers every 10 feet.

9. Design team should be aware that over-all length of LN2 piping system will shorten 3-1/2 inch per 100 feet of pipe when filled with LN2 due to thermal contraction.

10. 02 monitors in the freezer room shall alarm to the BAS upon oxygen depletion due to displacement of oxygen by the heavier nitrogen gas. The BAS should be programmed to close LN2 feed valve upon 02 depletion in the freezer room.

11. Freezer room exhaust shall be located close to the floor in LN2 freezer rooms. Temperature sensors should also be located in the low exhaust duct to alarm to the BAS upon low temperature caused by leakage of LN2 into the freezer room.

Liquid Nitrogen Piping Requirements	
Pipe	Schedule 5, type 304 SS double walled vacuum jacketed
Insulation	Multiple layers of cryo paper and Al foil or Al. Mylar
Relief Vents	Required wherever liquid can be trapped between valves
Shrinkage	3-1/2 inches per 100 feet of pipe when LN2 filled
02 Deletion Monitors	Required in freezer rooms with alarms and logic to shutoff to BAS
Room Exhaust	Must be low, 18 inches from floor
Temp Sensor	Should be located in low exhaust alarming to BAS on low temp.

E. References:

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Design Parameters.

Guide for the Care and use of Laboratory Animals, revised 1996. NIH Pub. No. 85-23. Washington, DC Public Health Service.

Chart Industries Design Guide for Liquid Nitrogen Piping, 2004

2.2.8 Fire Protection A. Introduction

With the exception of elevator shafts and the CenterPoint Energy main power supply vault, all areas of the building will be protected by a total coverage automatic wet sprinkler system.

1. Office and general building spaces will be classified as Light Hazard occupancies.
2. Animal holding rooms, animal procedure rooms, penthouse and other mechanical areas will be classifies as Ordinary Hazard Group 1.
3. Dock areas, all laboratories, including corridors between labs, will be classified Ordinary Hazard Group 2.
4. UT HEALTH Environmental Health and Safety should be consulted on all fire protection design guidelines.
5. The fire suppression system will be hydraulically designed in accordance with NFPA-13 guidelines.

B. Data

1. Areas subject to freezing conditions will be protected by a dry pipe sprinkler system.
2. Hydraulic design densities will be determined from discussions with the insurance underwriter and local fire local fire authorities. Fire hose cabinets (valve without hose) will be provided as approved by the insurance authority.
3. 2-1/2' fire department valve connections will be provided in all stairwells at each floor landing and on each floor as required so that a travel distance from a hose valve to most remote points can be serviced with a hose stream with a distance not exceeding 130 feet.
4. A fire pump and jockey pump will be provided to satisfy pressure and flow requirements for the facility to supplement the available pressure and flow from the municipal water system.
5. An appropriately sized tank will be provided to supply fire pump and be in accordance with City of San Antonio requirements.
6. The fire service to the building will be split from the domestic service outside the building.

C. Standard

1. Automatic Sprinklers
   a. The maximum allowable velocity permitted in the automatic sprinkler system shall be thirty-two (32) feet per second.
   b. Use fast response sprinkler heads throughout the facility.

2. Water Flow Test
   a. A water flow test must be conducted to determine the characteristics of the water supply. The water flow test shall be conducted by a licensed fire protection contractor.
   b. The insuring agency and local water department shall be present to witness the test.
   c. The procedure utilized for the test including the hydrant locations and the time of day must be recorded.
   d. For design purposes, a minimum of 10 pounds per square inch gauge (PSIG) safety factor shall be applied to the test results to allow for future fall off in the flow and pressure. The fire protection system shall be designed with this safety factor applied.

3. Piping and Fittings (See UT HEALTH Master Specifications for latest material requirements.)

   a. **Underground piping and fittings:**
      1. Pipe: Class 52 ductile iron, ANSI A21.51.
      2. Fittings: Ductile iron mechanical joint, 250 lb., ANSI A2.10.
      3. Lining: Cement mortar lining for pipe and fittings, ANSI A21.4.
      4. Coating: Bituminous seal coating.
      5. Joints: Push-on gasketed joints ANSI A21.11 with neoprene gasket.

b. **Interior above ground piping and fittings:**

1. Piping: Welded or seamless black steel pipe, ASTM A53, A135 or A795.
2. Class: Schedule 40 for 6" in. and smaller and Schedule 30 for 8" in. and larger.
3. Fittings: Malleable iron threaded, Class 150 or 300 ANSI B16.3 as required due to system pressure.
4. Fittings: Cast iron threaded, Class 125 or Class 250, ANSI B16.4 as required due to system pressure.
5. Fittings: Malleable iron mechanical grooved fittings and couplings ASTM A-47, 500 psi minimum with EPDM gasket, U.L. Listed or F.M. Approved.
6. 2" through 6" size — rolled groove type; 8" size and larger — cut groove type
7. Fittings: Factory fabricated wrought steel butt-welded, ANSI B16.9.
8. Fittings: Cast iron flanged, Class 125 or 250, ANSI B16.1 with 1/8" minimum, red rubber gaskets.

D. References

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

NFPA 13.

2.2.9 Sanitary Waste and Vent

A. Introduction

A sanitary waste and vent system will be provided to drain all domestic waste producing fixtures, lab sinks, mechanical equipment, and all animal areas. All fixtures will be trapped and vented to atmosphere. The building system is anticipated to flow by gravity to the exterior municipal sanitary sewer. Lift pumps will be provided to serve areas incapable of gravity flow. The duplex sanitary ejector will have each pump sized at 100%. The duplex systems will have a removal system for each pump.

B. Background

1. The NE shall develop plans, schedules, isometric or flat riser diagrams and details indicating all information required to clearly illustrate the intent of system design. All piping shall be located and sized on contract drawings.

2. Floor plans and riser diagrams shall include, but not be limited to identification of all sanitary waste piping from fixtures to connection to exterior sewer, all vent piping from fixtures and stacks to termination through roof, cleanouts, fixture and equipment identification, traps and trap primer lines.

3. Calculated fixture units used for system design shall be noted at house drains exiting the building, base of stacks, floor branch connections at stacks, ejector pump system discharge and interceptor inlets.

4. Invert elevations shall be noted at all drains exiting the building perimeter, connections to exterior sewers, uppermost point of each main and branch line located below ground level, and all other points where required to clearly establish proper slope and coordination with other piping systems and building components.

5. Bottom of pipe elevations shall be noted for unburied piping at locations where close coordination is required to prevent conflicts with other systems and/or building components.

6. Graphically identify each stack on plans and riser diagrams. Stack identification on riser diagrams shall correspond to stack identification on plans. Graphically indicate floor levels and floor elevations on riser diagrams.

7. Details shall be provided for, interceptors, cleanouts, roof penetrations, floor and wall penetrations, sewage ejector pump systems and all other components that require installation explanation beyond the information included within plans and riser diagrams.

8. Schedules shall clearly identify: Capacity, size, model, options and other requirements for all interceptors and sewage ejector pump equipment; Piping materials and piping support spacing.

C. Data

1. The waste systems will be designed using fixture drain loads established by the governing State and local codes, maintaining a minimum 2 FPS velocity.

2. Condensate waste will be insulated to a point 20 feet downstream of the point of origin.

3. A sampling manhole will be provided on the building sewer prior to connection to the municipal sanitary sewer.

4. Cleanouts will be accessible from walls or floors and interstitial levels.

D. Standard

1. Sanitary waste and vent systems shall be provided for all plumbing fixtures, floor drains, food service fixtures and equipment, and all other domestic waste producing equipment, systems and devices that are required by code to discharge into the sanitary sewer.

2. Waste and vent systems shall be designed using fixture drain loads established by code and provide proper operation during periods of peak demand.

3. Main waste and vent stacks shall utilize chases or be located adjacent to columns where possible for vertical routing to multiple floor levels.

4. Capped waste and vent connections for future extensions shall be located accessibly and not extend more than 24" from an active line. Waste and vent connections shall be located at elevations that will allow future installation of properly sloped piping without the need to dismantle or relocate installed ductwork, piping, conduit, light fixtures, etc.

5. The building system is anticipated to flow by gravity to the exterior municipal sanitary sewer. Sanitary waste serving fixtures located below the 500 year flood plane or waste that cannot be discharged by gravity shall flow into a gas-tight, covered and vented sump from which the waste shall be lifted by automatic pumping equipment and discharged into a sanitary waste drain capable of gravity flow. Sewage ejector pumps shall be minimum duplex system sized to discharge peak calculated load with one pump out of service. Pumps shall be connected to emergency power source. Sumps and ejectors handling sewage shall not receive storm or subsoil/foundation drainage.

6. Above ground floor drains, P-traps and first 20 feet of connected drainage piping receiving condensate or ice machine waste shall be properly insulated to prevent condensation.

7. Provide cleanouts at locations and with clearances as required by the code, at the base of each waste stack and at intervals not exceeding 90 feet in horizontal runs. All interior cleanouts shall be accessible from walls or floors. Coordinate the location of all cleanouts with the architectural features of the building and obtain approval of locations from the Project Architect.

8. No buried waste line shall be smaller than 2". No vent line shall be smaller than 1-1/2". No roof vent terminal shall be smaller than 3". Waste piping serving water closets shall not be smaller than 4".

9. Locate all sanitary vent terminals a minimum of 25 feet horizontally from or 3 feet vertically above all air intakes, operable windows, doors and any other building openings.

10. Avoid locating drains above sensitive equipment or areas where water leakage would cause major property loss or contamination, including but not limited to computer data centers, food preparation, food storage, animal holding rooms, etc.

11. Do not locate drainage or vent piping within stairways, electrical or telecommunications rooms.

12. Provide floor drains in all toilet rooms that are designed to be occupied by more than one user at a time (e.g., containing two or more water closets or a combination of one water closet and one urinal).

13. All traps shall be properly vented in accordance with the applicable code.

14. Provide automatic trap primer for all floor, floor sinks and hub drains that may be susceptible to trap seal evaporation.

15. Provide a submersible sump pump in each elevator pit. Sump pumps shall be simplex, plug in type with

automatic, float actuated on/off control. Pump discharge shall not be directly connected to storm or sanitary systems. Electrical service shall be connected to emergency power source. Provide electrical power switch for pump control and a hose bib for pump effluent discharge. Locate switch and hose bib within access of elevator door.

16. Sanitary waste and vent piping serving all domestic waste fixtures and animal areas will be heavy-duty, cast iron, pipe and fittings.

17. Cast iron pipe sizes 8" and smaller will utilize standard weight, no-hub couplings. Cast iron pipe sizes 10" and larger will be hub and spigot with Tyseal gasket push joints.

18. Lab sinks and cup sinks in hoods will be piped with schedule 40 flame retardant polypropylene pipe and fittings with mechanical joints. Fixture traps and branches will be polypropylene. Branches will then connect to the main cast iron sanitary waste and vent system.

E. References

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

2.2.10 Storm Sewer

A. Introduction

A storm water drainage system will be provided to convey rainwater from roof and area drains to the site municipal storm sewer system. The system is anticipated to flow by gravity to the site storm water system. Lift pumps will be duplex with each pump sized at 100% provided to serve areas incapable of gravity flow. A building subsoil foundation drain system will be provided as determined by soil boring analysis.

B. Background

1. The NE shall develop plans, schedules, isometric or flat riser diagrams and details indicating all information required to clearly illustrate the intent of system design. All piping shall be located and sized on contract drawings.

2. Floor plans and riser diagrams shall include, but not be limited to identification of all roof drains, area drains and piping.

3. Area square footages used for system design shall be noted at each roof drain, area drain, house drains exiting the building, base of downspouts, branch connections at downspouts, and sump pump system.

4. Invert elevations shall be noted at all drains exiting the building perimeter, connections to exterior sewers, uppermost point of each main and branch line located below ground level, and all other points where required to clearly establish proper slope and coordination with other piping systems and building components.

5. Bottom of pipe elevations shall be noted for unburied piping at locations where close coordination is required to prevent conflicts with other systems and/or building components.

6. Graphically identify each roof drain, area drain and downspout on plans and riser diagrams. Identification on riser diagrams shall correspond to identification on plans. Graphically indicate floor levels and floor elevations on riser diagrams.

7. Details shall be provided for, cleanouts, roof drains, area drains, sump pump systems, roof penetrations, floor and wall penetrations, and all other components that require installation explanation beyond the information included within plans and riser diagrams.

8. Schedules shall clearly identify: Capacity, size, model, options and other requirements for all sump pump equipment; Piping materials and piping support spacing.

C. Data

The storm water system will be designed using 8" per hour rainfall intensity in conjunction with code established areas-to-pipe sizes allowed. Horizontal piping inside building will be insulated.

D. Standard

1. Storm water drainage systems shall be provided to convey rainwater from roof and area drains to the site municipal storm sewer system. Secondary emergency overflow systems shall be installed to protect parapeted roof structures in the event of primary system blockage. The overflow system shall utilize parapet scuppers or secondary piping discharging through the exterior building wall immediately below the roof level. Aesthetics of scuppers and/or secondary piping termination shall be determined by the Project Architect.

2. Primary and secondary roof drain systems shall be designed using 8" per hour rainfall intensity in conjunction with code established areas-to-pipe sizes allowed.

3. Storm drains that cannot be discharged by gravity shall flow into a gas-tight, covered and vented sump from which the drainage shall be lifted by automatic pumping equipment and discharged into a storm drain capable of gravity flow. Storm water lift pumps shall be minimum duplex system sized to discharge maximum calculated load with one pump out of service. Pumps shall be connected to emergency power source. Sumps and lift pumps handling storm drainage shall not receive sanitary drainage.

4. Roof drainage system shall not connect to subsoil/foundation drainage or any open storm drain piping located within the building.

5. Roof drain and emergency overflow drain sumps and horizontal piping to first vertical downspout shall be insulated to prevent condensation.

6. Provide cleanouts at the base of each vertical downspout and at intervals not exceeding 90 feet in horizontal building drain. Provide clearances as required by code. All interior cleanouts shall be accessible from walls or floors. Coordinate the location of all cleanouts with the architectural features of the building and obtain approval of locations from the Project Architect. Horizontal roof drain piping located above building ground floor level will not require cleanouts.

7. No roof drain shall have an outlet connection smaller than 3".

8. Avoid locating drain sumps or piping above sensitive equipment or areas where water leakage would cause major property loss or contamination, including but not limited to computer data centers, MRI rooms, food preparation, food storage, food serving, animal housing care areas, etc.

9. Do not locate drain sumps or piping within stairways, electrical or telecommunications rooms.

10. Appropriate subsoil and foundation drainage shall be provided as required by the geotechnical report. Due to elevations of foundations and city utilities, all subsoil drainage shall be discharged from the building through a lift station with duplex pumps. Each pump shall be sized for 100% of design capacity. Sumps and pumps handling sub-soil/foundation drainage shall not receive any sewage or roof drainage.

11. All interior downspouts and interior storm drainage piping, and all such piping up to a point five feet (5') outside the building walls, or to any other point indicated on the Drawings, shall be service weight cast iron soil pipe, hub and spigot for pipe ten inch (10") and larger and hubless for eight inch (8") and smaller. Each piece of pipe and each fitting shall be coated at the factory with asphaltum or coal tar pitch and with the manufacturer's mark or name cast on it.

12. Exterior storm water drainage piping from a point five feet (5') outside building walls or to point shown shall be ductile iron pipe with restrained mechanical joints.

E. References

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

UT UT HEALTH Design Guidelines. South Campus Vivarium Project 04-0032. April 11, 2005.

2.2.11 Site Utilities

A. Introduction

1. Water services shall be brought to the site from the Municipal system. Domestic, fire protection, and lawn

irrigation water supply systems shall be metered and isolated from the municipal water supply in accordance with City of San Antonio requirements.

2. Sanitary Sewer services shall be brought to the site from the Municipal system. Provide sanitary drainage system to serve site and structures.

3. Storm Sewer services shall be brought to the site from the Municipal system. Provide storm drainage system to serve site and structures.

4. Natural gas service shall be brought to the site from the Local Gas Supplier's System. Coordinate with Gas Company for service line easement and meter placement requirements. Coordinate routing of gas service with other site utilities.

B. Background

1. The site utilities will be designed by an approved and licensed Civil Engineering consultant.
2. Sanitary and storm drainage systems shall be entirely separate.
3. All storm sewer lines and structures shall be constructed according to City of San Antonio standards.
4. Provide on-site detention as required by the City of San Antonio.
5. All sanitary sewer lines and structures shall be constructed according to City of San Antonio standards.
6. All site natural gas lines and structures shall be constructed according to NFPA 54 and the Gas Company's standards.

C. Standard:

1. Water Services

    a. Provide fire hydrants as required by City of San Antonio Fire Marshal. Maximum spacing between hydrants should not exceed 300 feet. Locate such that any portion of the exterior of any building shall be within 300 feet of a hydrant, with consideration given to accessibility and obstructions. Nominal distance between a fire hydrant and the building fire department connection should not exceed 100 feet.

    b. The building water supply will be provided by the existing municipal water main.

    c. The building fire protection water supply will be provided from the building water system.

    d. The building water supply will connect to the existing municipal water main. A single feed will run into the building and split inside the building to a domestic supply and fire protection supply. Backflow protection to the municipal main will be provided in the form of parallel reduced pressure backflow preventers.

    e. The building fire protection water supply will be a sub-system of the building's internal water supply. A fire department Siamese connection will be provided.

2. Sanitary Service

    a. The building sanitary sewer will flow by gravity to the city sanitary sewer system. Manholes will be placed approximately 200 feet apart.

    b. System design shall prevent site sanitary waste water from flowing into the building piping systems. Provide backwater valves manufactured by Tideflex on inlet piping of manholes, area inlets or junction boxes directly receiving discharge from building systems.

    c. Wastes which are likely to damage or increase maintenance costs on the sanitary sewer system, detrimentally affect sewage treatment, or contaminate surface or subsurface waters, shall be pretreated to render them innocuous prior to discharge into a drainage system. Provide detailed plans and specifications of the pretreatment facilities to the Municipal Authority when such plans and specifications will aid in enforcing the provisions of the Municipality's Codes, Laws or Ordinances. Piping conveying wastes from their point of origin to sewer connected pretreatment facilities shall be of such material and design as to adequately perform its intended function to the satisfaction of the Administrative Authority. Drainage discharge piping from pretreatment facilities or interceptors shall conform to standard drainage installation procedure.

    d. Provide interceptors for all drainage that may contain grease. Interceptors shall be precast concrete with two-compartments (construction and size based on the City of San Antonio Plumbing Code). Each compartment shall be provided with two gas and water tight 24" minimum diameter manholes for access. Interceptors shall be properly vented to atmosphere and located outside the building footprint convenient to vehicular access for servicing. Provide waste sampling well immediately downstream of interceptor per City of San Antonio requirements.

e. Provide chemical waste treatment basins when effluent is expected to have a pH less than 6 or more than 10 before discharging into municipal sewer systems. Basins shall be provided with gas and water tight cover of adequate size for servicing. Basins shall be properly vented to atmosphere and located outside the building footprint convenient to vehicular access for servicing. Provide waste sampling well immediately downstream of basin per City of San Antonio requirements.

f. Effluent having a temperature above 113° F shall not be discharged to the municipal drainage system.

3. Storm Sewer Service

a. The building storm sewer will flow by gravity to the city storm sewerage system. Manholes will be placed approximately 200 feet apart. Multiple storm sewer connections are anticipated due to the area being drained.

b. System design shall prevent site storm water from flowing into the building piping systems. Provide backwater valves manufactured by Tideflex on inlet piping of manholes, area inlets or junction boxes directly receiving discharge from building systems.

4. Natural Gas Service

a. The A/E team shall investigate natural gas availability, service location, available service pressure, and any restrictions on the use of the natural gas. Interruptible and non- interruptible gas services shall be evaluated regarding program requirements. Ownership and maintenance of proposed gas service shall be determined. Include an "allowance" in the project equal to the estimated costs (quote) of the utility company as a separate item in design phase estimates.

b. Unless otherwise approved by The University, the A/E shall include all costs associated with the installation of gas service (including materials, labor, procurement, scheduling, etc.) in the bid documents as the Contractor's responsibility, both during bidding and construction.

c. Where natural gas service piping, meters, regulators, and other appurtenances are provided by the utility company, and the construction costs are assessed to UT HEALTH, the A/E shall obtain from the utility company a written scope of work, quote, contact person, and any scheduling requirements.

d. Finished site work, such as concrete/asphalt paving, seeding, directly related to the natural gas line installation, or other miscellaneous work associated with the natural gas service installation shall be determined and defined in the bidding documents as the responsibility of the contractor, rather than the utility company.

e. Natural gas pressures shall not exceed five pounds per square inch gauge on customer side of the meter.

Site Utility Services	
Pipe Material:	1. Sanitary sewer piping will be heavy duty cast iron.
(See Master	2. Storm sewer piping will be reinforced concrete piping.

Specifications)	3. Water supply will be Class 52 ductile iron piping.

D. References

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

CUH2A, I. 7.0 UT HEALTH Mechanical Design Requirements. 2006). City of San Antonio Codes and Standards. Latest Edition.

NFPA as applies to Natural Gas Piping.

3. Mechanical Systems

3.1 General Criteria

3.1.1 Temperature & Humidity Design Conditions

A. Introduction

Laboratory animals must be housed in comfortable, clean, temperature and humidity- controlled rooms. Animal welfare must be considered in the design process and the HVAC system must provide a comfortable environment for both the research animals and human staff. There can be a marked difference between the environment in the primary and secondary enclosure. Temperature/humidity ranges are recommended for the secondary enclosure (animal room) with the historical assumption that these conditions produce an acceptable environment.

B. Background

Most laboratory animals prefer a relative humidity around 50%, but can tolerate a range of 30 — 70% as long as it remains relatively constant and the temperature range is appropriate. The ventilation system should be capable of adjustments in dry-bulb temperatures of IC (± 2F) and usually range from 61F to 84F.

C. Standard

Recommended Dry-Bulb Temperatures and Humidity for Animal Housing		
	Temperature (°F)	**Humidity**
Mouse	68F to 79F	30-70% RH
Hamster	68F to 79F	30-70% RH
Guinea pig	68F to 79F	30-70% RH
Rabbit	61F to 72F	30-70% RH
Dog	64F to 84F	30-70% RH
Non-human primate	64F to 84F	45-70% RH
Chicken	61F to 81F	45-70% RH

D. References

National Research Council, Institute of Laboratory Animal Resources. 2011. The Guide for the Care and Use of Laboratory Animals. Chapter 3.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-17 to D-19.

Canadian Council on Animal Care, Guide to the Care and Use of Experimental Animals Section III.A.2 and A.3

ASHRAE Standard 52-76, Filtration Testing parameters.

3.1.2 Building HVAC Loads

A. Introduction

In the past UT HEALTH has not required the MEP consultant to provide building load calculations for vivaria, labs or any other type building. It is the intent of this document to require the consultant to provide electronic load calculations for all projects. The intent of this process is to identify room requirements early in the design so that there is an understanding of what cooling load is anticipated for each room in the building. The load calculations and associated notes made in the software inputs will:

1. Allow all parties to review and agree on what is anticipated for each room early in the project.
2. Serve as a basis of design document that can be updated as project changes are made.
3. Allow utilities management to plan for chilled water and steam requirements early in the project.
4. Select most stringent requirement to determine room air quantity (heat load or air change).
5. Allow user to see how many animals were assumed in the room calculation (notes).
6. Allow user to see what equipment was assumed in the room calculation (notes).
7. 7. Allow verification of envelope energy requirements.

B. Background

Computer based HVAC load calculation programs have been available for many years and are typically used by most consultants on all projects. What is being asked of the consultant that is normally not done, is to itemize a list of equipment expected for each room as well as assumed animal counts. The software is generally used for commercial applications. Inputs are specific to lighting, equipment, people and the building envelope. Therefore, the equipment input must sum up the animal and equipment heat loads. To allow all parties to know what is included in the equipment input, the notes section for each zone will break down how many animals were used for the calculation and what equipment and heat load was assumed for the calculation. Additionally, the notes shall describe other room requirements such as: type and number of BSCs expected in the room, quantity of exhaust required for the BSC or the room, and relative room pressurization (positive or negative), etc.

C. Data

In past projects, identification of specific room requirements has been limited to the programming architect or the equipment consultant. Eventually, the information is then forwarded to the engineer to begin the design process. The goal is to include the engineer early in the design process so that a document is generated that clearly identifies specific room requirements. These room requirements can then be calculated and submitted to The University for review prior to system layout or equipment selection. The goal is to speed up the design process by allowing faculty, users, project managers and internal engineering to review one design document all at one time. The review comments are then incorporated into the load calculation software, verified and then used by the engineer to begin the design of the supply and exhaust systems.

D. Standard

The consultant shall input all project rooms/entire building heat loads into the calculation. The software employed by the consultant shall include all ASHRAE standards. The UT HEALTH preferred software is Elite Software — CHVAC Commercial HVAC Loads. The load calculations shall be based on project programming and shall be submitted to The University through the project manager for review by all parties. An architectural floor plan with room numbers shall be provided to correlate the plan with the load calculation printout.

E. References

ASHRAE Handbook —Fundamentals. 2005.

3.1.3 Noise and Vibration

A. Introduction

Many animals are extremely sensitive to noise, hammer drill, and vibration during construction, which can produce detrimental effects on research. Designers shall take every opportunity to control vibration and to locate vibration sources away from animals and activities sensitive to vibration. Specific vibration recommendations shall be made by an experienced vibration consultant early in the design process. Steel structures shall not be precluded for use in structural design relative to vibration without analysis. Blanket use of sound attenuators at the room zone level should be avoided.

B. Background

Animal housing and most procedure spaces should be carefully designed to facilitate animal wellbeing; meet research requirements; minimize experimental variables; and provide isolation from wide variations in vibration and noise sources.

Noise controls should be considered in all facility designs and operations. Moreover, the facility should assess the following factors: intensity, frequency, rapidity of onset, duration, vibration potential of sound, hearing range, noise-exposure history, and sound-affect susceptibility of species, stock, or strain. Exposure to sound louder than 85 dB can have numerous adverse affects on animals. Examples of these adverse effects include: increased nervousness, irritability, hearing impairment, anxiety, hypertension and decreased reproduction.

When designing a renovation or new construction all items should be considered and noise abatement measures should be implemented as needed. When selecting sound absorption materials (wall baffles, etc.), the ergonomics of sanitizing and handling the materials in the facility should also be kept in mind.

Consideration shall be given to vibration of floor-framing systems caused by mechanical and electrical equipment such as pumps, chillers, fans, emergency generators, and transformers and other sources such as foot traffic, parking garage traffic, and movement of heavy equipment.

Designers should consider the effects of noise generated by equipment and materials in facilities. Likewise, designers should separate animal housing and procedures areas from high noise areas and activities and consider installing sound attenuating material as needed. Small-animal holding rooms should be located convenient to a central cagewash, but at a minimum they should be separated from the cagewash by a corridor. Likewise, to minimize the impact of noise and vibration, the holding rooms should be separated from mechanical rooms or other noise-generating areas in the facility. This is particularly necessary for barrier areas where genetically sensitive animals are housed.

Rodents can hear ultrasound. Their hearing range is from 20 Hz to 100 KHz. Since ultrasonic motion detectors transmit ultrasonic sound waves in the frequency range from 25 KHz to 40 KHz, the lab rodents may be subject to auditory stress. A sister cancer research institution had ultrasonic motion detectors installed in the vivarium corridors. The ultrasonic sound waves could not penetrate the walls at low level. However, when the doors of the animal rooms were opened, the rodents were stressed with full level of ultrasound which decreased reproductive performance. After the removal of the ultrasound sources, the rodents reproductive performance returned to normal levels.

C. Standard

To control vibration transmitted into the animal facility space, the NE team shall consider the following items during the early design phases:

Noise and Vibration Standard	
Recommendation	**Justification**

Structural system should have relatively short column spacing and be relatively stiff so that any transmitted vibration occurs at high frequencies.	Vibrations occurring at higher frequencies are more easily dampened with instrumentation vibration-dampening systems and isolation tables than vibrations occurring at lower frequencies
Framed floors, corridors and animal facility spaces should not be combined in the same structural bay.	To reduce vibration occurrences and reduce detrimental effects on research animals and personnel.
Animal facility spaces should be located away from sources of vibration.	To reduce vibration occurrences and reduce detrimental effects on research animals and personnel.
Animal facilities should be located on grade- supported slabs.	This not only reduces vibration concerns but more easily accommodates pits required for cage and rack processing, and the risk of water leakage to lower levels is eliminated.
Ultrasonic motion detectors should not be used for lighting controls or security.	Ultrasonic motion detectors should not be used in vivarium corridors. Ultrasound noise levels should not be more than 15 dB above normal (ambient) ultrasound levels in cage rack rooms. Other possible application is passive infrared (P I R) occupant sensors.
Small-animal holding rooms should be separated from the cagewash by a corridor.	To reduce vibration occurrences and reduce detrimental effects on research
Vibration isolators should be installed appropriately on equipment that may be a source of vibration.	To reduce point source vibrations and reduce detrimental effects on research animals.

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities.

3.1.4 Building Pressure Relationships

A. Introduction

Differential pressures can be used to inhibit the passage of pathogenic material between rooms. Higher pressures are used in clean areas relative to dirty or bio-hazardous areas in order to minimize contamination.

B. Background

Consideration should be give to the manipulation of air-pressure differentials in surgical, procedural, housing and service rooms. For example, areas for quarantine, housing of nonhuman primates, and use of animals exposed to hazardous agents should be kept under relative negative pressure; whereas areas for surgery, for clean-equipment use and storage, and for housing of pathogen-free animals should be kept under relative positive pressure with clean air.

The HVAC system must be adequate and adaptable so that pressure relationships can be modified as required over the life of the facility.

C. Standard

Room Type	Negative Pressure	Positive Pressure
Quarantine rooms	X	
Housing rooms of non-human primates	X	
Housing rooms for animals exposed to hazard-	X	
Cage wash - Soiled side to corridor	X	
Cage wash — Clean side to corridor		X
Necropsy rooms	X	
Autoclave - Equipment preparation	X	
Autoclave — Sterile staging		X
Surgery		X
Clean-equipment use and storage rooms		X
Housing rooms of pathogen-free animals		X
Bedding and feed storage rooms		X

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-17 to D-19.

Canadian Council on Animal Care, Guide to the Care and Use of Experimental Animals Section III.A.2 and A.3

3.1.5 Pipe Sizing A. Introduction

Steam, chilled and heating hot water piping represent the majority and largest piping systems serving the vivarium and support spaces. These systems support all the air handling systems and the vivarium process equipment, and are part of the heating, ventilating and air conditioning (HVAC) system. Pipe systems such as storm, sanitary, domestic water, reverse osmosis (RO) water, lab gases, LN2, fire protection, etc. although equally as important, have been excluded from the general sizing criteria since project specifics in many cases drive the design and sizing criteria. The following criteria shall be used in sizing the HVAC piping systems:

1. All piping sized for actual need without over sizing, to minimize initial pipe, valve, fitting, insulation and installation cost.
2. All piping sized for actual load to avoid unnecessary energy losses through pipe, steam piping in particular.
3. Maintain lower steam velocities near vivarium areas as needed to avoid noise transmission into occupied spaces.
4. Maintain higher chilled water delta where possible to reduce pipe sizes.

B. Background

To maintain the cooling and heating needs of the vivarium, the steam, steam condensate, heating hot water and process water systems shall be sized to accommodate current and future needs. Sizing for future load should be included only when an actual load is anticipated. System diversity should also be considered by the A/E team at the various building mains and risers. Smaller branch piping directly off the main and the end of mains, should follow the tabled criteria below.

C. Data

Based on reviewing many past UT HEALTH projects, HVAC piping is always generally over sized. The NE team shall look at possible diversity in the different systems to avoid the additional cost associated with oversized pipe. There are no known utility problems associated with pipe mains being too small.

D. Standard

HVAC Piping Sizing Requirements	
Item	**Direction**
Chilled and Process Water	
%" to 2"	2-3 ft friction loss per 100 ft of pipe.
2" and greater	3-4 ft friction loss per 100 ft of pipe.
Heating Hot Water Piping	
%' to 2"	2-3 ft friction loss per 100 ft of pipe.
2" and greater	3-4 ft friction loss per 100 ft of pipe.
Steam Piping	
Low (5-15 PSIG) and Medium (16-80 PSIG) pressure piping	50-80 ft per second (3000-4800 FPM)
High Pressure Piping	
(81-120 PSIG)	80-100 ft per second (4800-6000 FPM)
Condensate Return Piping	
5-30 PSIG return line	Maximum 10" water gage per 100 ft of travel using twice the running load.
31 PSIG and greater	66 ft per second maximum.

E. References

Spirex Sarco Design of Fluid Systems — Hook Ups -1992.

3.1.6 Ductwork Sizing

A. Introduction

Sheet metal ductwork distributes supply air or gathers exhaust air from the various vivarium spaces. Duct size, along with duct construction class determine the limits at which air can be effectively moved by the building air handling units and exhaust fans. Since duct construction is so intertwined with duct sizing, both topics are discussed herein. A typical duct system will include low and medium pressure duct construction classes. Generally, the duct sized for a low pressure class has a lower duct velocity or FPM (feet per minute) and requires less rigidity than a medium pressure duct that has a greater duct velocity. The lower velocity duct is normally at and around the room air device and is separated from the higher velocity medium pressure duct mains by a terminal unit that acts like a pressure regulator. This allows the main distribution ductwork to be smaller and maintain higher velocities which in turn reduces initial cost and requires less space above the ceiling. Exhaust systems requiring HEPA and charcoal filtration fall into the high pressure construction class. The duct classes are typically broken out as follows:

1. Low Pressure Ductwork - 2" water gauge (pressure measurement)

2. Medium Pressure Ductwork - 6" water gauge (pressure measurement) 3. High Pressure Ductwork - 10" water gauge (pressure measurement)

Once installed, each pressure class of duct is tested with an inclined or U-tube manometer, tubing, calibrated orifice and a test fan. Before the system ducts are attached to their respective fans or terminal units, a tube is inserted into the duct being tested. The other end of the tube is attached to one end of the manometer. The test exhaust fan is then energized and regulated to raise the fluid (water column or gauge) in the manometer to a 2", 6" or 10" differential as needed to meet the duct pressure class being tested. During the test the duct should not experience any opening of joints, tearing of joint corners, screw or rivet pullout, longitudinal seam separation, sealant failure or excessive deflection (oil canning). If any of these occur, the affected area shall be evaluated for repair or replacement, corrective measures taken and the entire system retested.

B. Background

To maintain the requirements of the vivarium, the duct systems must move air as efficiently and quietly (85 dB or less) as possible. The duct systems must also be constructed to withstand abnormal conditions which occur during loss of power, control failures or equipment failures. The duct systems must also accommodate normal air fluctuations associated with variable air flow without any flexing or oil canning of the ductwork. Oil canning of any ductwork is unacceptable in the vivarium. Typically, round duct is less susceptible to oil canning and is preferred.

Improperly sized duct, normally undersized, can cause discomfort or insufficient air change rate in vivarium spaces because designed air quantities cannot be achieved. Undersized duct and improper duct fittings also require the amount of horsepower needed to supply and exhaust vivarium spaces to increase. When the horsepower increases, the static pressure in the duct also increases and so will the air noise in the duct. If the duct static pressure increases beyond the limits of the duct construction rating, duct failures can occur. The duct static pressure ratings and criteria noted in the table below are minimum standards. The AE team shall fully investigate the duct systems required for the project and increase the duct size and construction class as required to meet specific project requirements. The AE team shall also carefully review ductwork shop drawings so that ducts, fittings and transitions effectively move air without increasing system static pressures. The duct systems should deliver the air to and from the building in the most efficient manner through proper duct sizing. Ductwork, however should not be oversized.

C. Data

Based on shared experience between designer and maintenance provider, the following elements listed in the table below should be used in designing a UT HEALTH vivarium.

D. Standard

Ductwork Sizing and Construction Requirements Vivarium and Support Areas	
Item	**Direction**

Supply duct from air handling unit (AHU) to risers and mains. Exhaust duct from mains and risers to exhaust fans.	Galvanized duct (unless otherwise noted) constructed to 6" pressure class. Duct sized for maximum friction loss of 0.157100 ft or 2000 FPM velocity, whichever is lower. Vertical risers serving multiple floors may be sized at 2500 FPM. End of main shall be sized for .057100 ft.
Supply duct from main to terminal unit. Exhaust duct from terminal unit to main.	Galvanized duct (unless otherwise noted) constructed to 6" pressure class. Maximum duct friction loss of 0.127100 ft preferred.
Supply duct from terminal unit to room air device. Exhaust duct from air device to terminal unit.	Galvanized duct (unless otherwise noted) constructed to 2' pressure class. Duct sized for maximum friction loss of 0.08"/100 ft or as required to meet room noise criteria level (could involve lowering duct velocity/larger duct size).
Biological Safety Cabinet exhaust to terminal unit	Galvanized duct constructed to 6" pressure class (304 stainless steel for IIB2). 10"-12" round duct minimum. Generally duct size equals terminal unit connection size.
Chemical Fume Hood (includes Radioisotope type) to terminal unit	316 (or 304, if approved by owner) stainless steel duct constructed to 6" pressure class. 12" round duct minimum. Generally duct size equals terminal unit connection size. Duct may be connected to galvanized general exhaust main.

Cage wash exhaust from grille/equipment to terminal unit	304 stainless steel duct (unless otherwise noted) constructed to 3" pressure class. Duct sized for friction loss of 0.15"/100 ft or 1800 FPM velocity. AE to size those ducts that are moisture laden (includes tunnel and rack washer) at the 1800 FPM velocity to remove moisture. Exhaust ductwork serving grilles in large open areas in the cage wash area can be galvanized, if not subject to constant moisture.
Cage wash exhaust from terminal unit to main. Cage wash exhaust from main to exhaust fan	304 stainless steel duct meeting 6" pressure class. Duct sized for friction loss of 0.2"/100 ft or 2200 FPM velocity. AE to size those ducts that are moisture laden (includes tunnel and rack washer) at the 2200 FPM velocity to remove moisture. Exhaust ductwork serving large open areas in the cage wash area can be galvanized, if not subject to constant moisture. Where one exhaust fan system serves all vivarium general exhaust and cage wash exhaust, a dedicated main from the cage wash shall be
Exhaust main upstream of filter caisson including run out to terminal unit.	304 stainless steel duct constructed to 6" pressure class. Duct sized for maximum friction loss of 0.15"/100 ft or 2000 FPM velocity, whichever is lower. End of exhaust main shall be sized for .05"/100 ft.
Exhaust main downstream of caisson, where required.	304 stainless steel duct constructed to 10" pressure class. Duct sized for maximum friction loss of 0.15"/100 ft or 2000 FPM velocity, whichever is lower.
Office Areas on Separate Air Handling Unit	

Supply duct from AHU to risers and mains	Galvanized duct constructed to 4' pressure class. Duct sized for maximum friction loss of 0.15"1100 ft or 1600 FPM velocity, whichever is lower. Vertical risers serving multiple floors may be sized at 2000 FPM. End of supply main shall be sized for .05"/100 ft.
Duct from main to terminal unit.	Galvanized duct constructed to 4' pressure class. Duct sized for maximum friction loss of 0.12"/100 ft preferred.
Duct from terminal unit to air device.	Galvanized duct constructed to 2" pressure class. Duct sized for maximum friction loss of 0.08"/100 ft or as required to meet room noise criteria (could involve lowering duct velocity/larger duct size). Runout ducts to individual diffusers may use a maximum of 6' flexible duct. Remaining runout length shall be rigid galvanized duct
Return and outside air ducts to air handling unit	Galvanized duct constructed to 4" pressure class. Duct sized for maximum friction loss of 0.10"/100 ft or 1600 FPM velocity, whichever is lower.
Return air transfer openings, boots and duct	Openings and ducts near mechanical room sized at 500 FPM, all other openings sized at 300 FPM.
Joining, Fittings, and Duct Sealing Standards (All Areas)	
Joining	SMACNA approved Flanged and gasketed transverse joints for medium and high pressure galvanized systems. Low pressure joints and transverse and longitudinal joints shall be minimum Pittsburgh Lock with sealant. All stainless steel duct joints shall be welded.

Fittings	Rectangular supply elbows shall have turning vanes, round or radius rectangular elbows shall be full radius, offsets shall be mitered or radiussed and transitions shall not exceed 30 degree angle for concentric or eccentric transitions.
Duct Sealing	All galvanized duct seams and joints must be sealed with an owner approved sealant and fiberglass scrim tape for a tighter, low leakage duct system.

E. References

SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc) — HVAC Duct Construction Standards, Metal and Flexible, Second Edition 1995.

3.2 System Descriptions

3.2.1 Plant Steam and Condensate

A. Introduction

Plant steam is used directly or indirectly for four processes; heating the building systems, creating clean steam, providing the heat source for washing and sterilizing of animal caging, and providing the heat source for washing and sterilizing glassware for the laboratory function. All four processes require an uninterrupted steam source to support the day-to-day vivarium operations. Generally, steam is extended to a piece of equipment for heat transfer. As the steam comes in contact with cooler surfaces, it is converted to liquid condensate. In most cases, this condensate is reclaimed and returned to the steam generator (boiler) to be reheated and returned to a high pressure gas state. However, some condensate will not be returned to the steam generator because of system inefficiencies or the condensate is not suitable for reuse. Softened makeup water is then preheated and extended to the generator to begin the steam generating process once again. Steam is either generated within the building or is generated at a central utility plant. The fuel source for the steam generation is usually natural gas.

B. Background

To maintain the requirements of the 24 hour/365 day vivarium operation, high pressure debris-free steam must be extended to the various support equipment. On the Main/North Campus, steam enters the building central plant at approximately 225 pounds per square inch gauge (PSIG) (could be as high as 425 PSIG) and is reduced to 70-150 PSIG through pressure reducing stations. Each station shall consist of a 1/3 capacity pressure reducing valve (PRV), 2/3 capacity valve and a full line valved bypass (AE to confirm bypass need). Pressure reductions greater than 100 PSI shall involve at least two reduction stages. Dedicated building steam boiler pressures should not exceed 100 PSIG. High steam pressures shall be limited to equipment within the central plant. Steam to equipment on the vivarium floor shall not exceed 80 PSIG.

Within the building main mechanical room, steam is used to heat domestic hot water, heat the heating hot water and create clean steam. Heat exchangers are used for the steam to steam or steam to heated liquid transfer. Steam to the vivarium decontamination bulk sterilizers, rack washers, tunnel washers, sterile bulk sterilizers and glassware washers and sterilizers shall not exceed 70 PSIG. Verify steam requirements with equipment supplier. Steam flow to all cage wash and glasswash equipment shall be controlled by the equipment served. Steam to clean steam generators and heating hot water exchangers shall be controlled through 1/3, 2/3 valve arrangement.

All plant steam piping shall be carbon steel.

Steam traps shall be provided at steam pressure reducing stations, equipment, end of pipe run, extended pipe runs, bottom of risers, steam headers, flash tanks, etc. All high pressure steam condensate shall be routed through flash tanks before being returned to the condensate return pump receiver. At the Main/North Campus, the condensate return pump shall pump condensate to the condensate transfer pump for return to TECO. For boiler systems, the condensate return pump shall pump condensate to the de-aerator boiler feed unit to be reused for makeup to the steam boiler. Condensate return pumps shall be duplex electric or steam powered. All pressure reliefs and vents shall be extended through the roof.

Plant steam shall have no direct contact with clean steam generator vessels, clean steam piping system, clean steam de-aerator vessel or direct injection into sterilizer chambers. The AE, owner and washing/sterilizing equipment provider shall establish and coordinate washing and sterilizing requirements at the programming phase.

C. Data

Based on shared experience between user, builder and maintenance provider, the following elements listed in the table below should be used in designing the UT HEALTH vivarium.

D. Standard

Steam System Requirements	
Item	**Direction**
Steam Pressure Ranges PSIG	
5-14	Low Pressure
15-80	Medium Pressure
81-120	High Pressure
121-425	High Pressure (TECO)
(Maximum steam pressure to equipment, although lower more efficient steam pressures are recommended. Consult washing/sterilizing equipment manufacturer for exact steam pressure, quantities and steam quality required.)	
Heating Hot Water System	80 PSIG max
Domestic Hot Water System	80 PSIG max
Clean Steam Generator	80 PSIG max
De-aerator	30 PSIG max
Bulk Sterilizer	70 PSIG max
Rack washer	70 PSIG max
Tunnel washer	70 PSIG max
Glass washer	70 PSIG max
Glass Dryer	70 PSIG max
Glass Autoclave	70 PSIG max
Distribution Piping	
Steam — All pressures	Standard weight carbon steel
Condensate — All pressures	Schedule 80 carbon steel for piping smaller than 1". Standard weight for piping larger than 1"
Screwed Pipe	Low and Medium pressure steam and condensate piping smaller than 2 Y2

Welded pipe	Low and Medium pressure steam and condensate piping larger than 2", and all high pressure steam and condensate piping.
Pipe slope	Maintain gravity condensate return as much as possible. Steam piping shall slope opposite steam flow
Pressure Reducing and Control valves	Pilot operated
Boilers (where required)	Minimum 2 - Gas fired water tube boilers each at 100% capacity, on emergency power. Three boilers each at 50% preferred. Boiler designed for 100 PSIG maximum.
De-aerator (where required)	Minimum 1 — de-aerator with 1 receiver and multiple feed pumps (1 standby) all on emergency power. Unit shall be equipped with steam preheat option to maintain boiler feed water at 210 degrees. Softened water boiler feed.
Condensate transfer pump (where required)	Minimum 1 receiver with multiple pumps on emergency power (1 standby). Pumps shall accommodate TECO condensate return system pressures 35-60 PSIG and 25-150 GPM flow rate.
Condensate return pump	All condensate return pumps shall be low pressure. Electric condensate return pumps shall be duplex on emergency power. Steam pressure powered condensate return pumps require only one pump.
Blowdown separator	1 required with discharge tempered to 120 degrees maximum.
General	Boilers and de-aerators shall be of the same manufacturer where possible.

E. References

Existing systems.

Cleaver-Brooks engineering manual.

3.2.2 Clean Steam

A. Introduction

Clean steam is used for humidification and sterilization. Clean steam is considered clean because there are no chemicals (amines) added to the steam to protect the distribution piping from corrosion. This clean steam is considered suitable for injection into the supply air serving the vivarium and support area air handling units during low humidity days. A relative humidity of 50% should be maintained year round. Clean steam is also injected into the glasswash and bulk sterilizers to complete the sterilization process. Clean steam can be generated by a plant steam to clean steam exchanger or by an electric clean steam generator. The water used to generate the steam is usually a combination of condensed clean steam (condensate) accumulated in the distribution piping and reverse osmosis (RO) makeup water. These two makeup water sources are gathered at a clean steam de-aerator. The de-aerator removes the oxygen from the liquid by heating it to 212 degrees before pumping it to the clean steam generator. The generator receives the heated water and converts it to steam at the desired pressure. The steam is then distributed by way of stainless steel piping to the air handlers and sterilizers. Currently, all clean steam serving UT HEALTH vivarium is generated through plant steam to clean steam generators.

B. Background

The clean steam must be available 24 hours/365 days a year to maintain the environmental conditions of the animals. Therefore, redundant clean steam generators are required. Generally, 70 PSIG clean steam is extended to the washing and sterilizing equipment. The pressure is reduced to 15 PSIG for the clean steam humidification system serving the air handlers. All metals in contact with the clean steam shall be stainless steel to avoid corrosion in the system. This should also include pipe vents and reliefs that could allow condensation to drip and mix with the clean steam.

The AE team shall coordinate the specification of all humidification, washing and sterilizing equipment with the manufacturer, so that all metals in contact with the clean steam are made of stainless steel. Any lapse in this requirement compromises the entire clean steam system. Some individual washing and sterilizing equipment will require both clean and plant steam. Needs should be coordinated with equipment manufacturer.

C. Data

Based on shared experience between user, builder designer and maintenance provider, the following elements shall also be used in designing an UT HEALTH vivarium.

D. Standard

Clean Steam System Requirements	
	Item Direction
Steam Pressure Ranges PSIG	
5-15	Low Pressure
16-80	Medium Pressure
(Maximum steam pressure to equipment, although lower more efficient steam pressures are *recommended. Consult washing/sterilizing equipment manufacturer for exact steam pressure, quantities and steam quality required.)*	
De-aerator	30 PSIG max
Bulk Sterilizer	70 PSIG max

Rack washer	70 PSIG max
Tunnel washer	70 PSIG max
Glass washer	70 PSIG max
Glass Dryer	70 PSIG max
Glass Autoclave	70 PSIG max
AHU Humidifiers	15 PSIG max.
Distribution Piping	
Steam — All pressures	304 schedule 40, seamless stainless steel.
Condensate — All pressures	304 schedule 40, seamless stainless steel.
Welded pipe	All steam and condensate piping.
Pipe slope	Maintain gravity condensate return as much as possible. Steam piping
Pressure Reducing Valves (station)	Pilot operated. Valves sized 1/3, 2/3 with bypass.
Clean Steam Generators	Minimum 2- steam to steam generators each sized for 85 to 90% capacity. Parts in contact with clean steam shall be 304 stainless steel. Generators shall produce 70 PSIG steam. All related controls shall be on emergency power.
Packaged Clean Steam De-aerator	Minimum 1 de-aerator with 1 receiver and multiple feed pumps (1 standby) all on emergency power. Unit shall be equipped with steam preheat option to maintain generator feed water at 210 degrees. All surfaces in contact with clean steam shall be stainless steel. Where screwed pipe is required on the system, provide thread sealers or seal tapes compatible with metal and high temperature. Provide RO makeup water.

Condensate return pumps	Provide steam pressure powered condensate return pump where required. All parts in contact with clean steam condensate shall be 304 stainless steel.
Slowdown Separator	1 required, discharge blow down shall be tempered to 120 degrees maximum.

E. References

NIH Design Policy and Guidelines-Animal Research Facilities, Spring 2003.

3.2.3 Heating Hot Water

A. Introduction

Heating hot water is used for the vivarium air handlers to preheat the 100% outside air to 4550 degrees in the winter. As the air is ducted to the individual animal rooms and support areas, a hot water reheat coil in the duct further heats the air as needed to maintain the desired temperature in the animal room or support zone. Generally, a thermostat in the room controls the reheat coil and the coil is in use year round to reheat the supply air. The air handler discharge ranges from 50-52 degrees. One heating hot water system will normally serve the entire building even if other occupancy types share the building. Natural gas is used to fuel a steam boiler that allows an exchanger (converter) to convert the steam to a heating hot water source, or natural gas is used to fuel a heating hot water boiler directly. In some cases steam may be used to preheat and reheat the air. Also, in some cases, the gas boilers are outfitted to handle fuel oil as an alternate fuel, but only in an emergency. Steam preheat/reheat boilers and duel fuel boilers are not recommended.

B. Background

To meet the 24 hour/365 day environmental heating requirement of the vivarium, the heating hot water system must maintain 140-160 degrees to the building air handling units and reheat coils. Generally, a 20 degree delta between heating hot water supply and return is required year round. A circulation pump shall be provided at the air handling unit preheat coil to maintain constant water flow through the coil. This will minimize the chance of freezing the coil when outside air temperatures are slightly below freezing.
The heating hot water system shall include an air separator and expansion tank to remove air in the piping system. The air separator shall be located on the suction side of the pump. Heating hot water return from the building shall first enter the steam to hot water exchanger/converter, then through the air separator and finally distributed to the building by the pump. Heating hot water distribution piping is generally schedule 40 black steel sized to 2 to 3 ft. friction loss per 100 feet of pipe. Where feasible, copper may be substituted for smaller branch lines. Piping shall be no smaller than'/"

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C. Data

Based on shared experience between user, builder, designer and maintenance provider, the following elements listed in the table below should be used in designing an UT HEALTH vivarium.

D. Standard

Heating Hot Water Requirements	
Item	Direction
Entire heating hot water system	All system components including controls shall be on emergency power,
Building heating hot water pumps	End suction pumps, minimum of 2 pumps each sized for 100% capacity and on emergency power. Pumps shall be provided with variable speed drives (VSD), isolation valves, strainer, check valve, flex connectors and housekeeping pad (inertia base where required). Typical for all buildings.
Distribution piping	Piping shall be schedule 40 black steel. Small branch lines may be copper where feasible. Dielectric unions shall be provided where dissimilar metals come in contact. Gaskets in the system shall be able to meet the maximum system temperature range plus 10% increase.
Air Separator	Provide at suction to pump
Expansion Tank	Provide and connect to air separator or provide at system high point. A/E team to verify best location.
Isolation Valves	Provide heating hot water supply and return isolation valves at bottom of riser, each floor take off from riser and at each piece of equipment.
Steam to Heating Hot Water Converter/Heat exchanger (Where applicable)	A minimum of two converters each sized for 100% capacity. Three converters at 50% each preferred.
Gas Fired Hot Water Boiler (where applicable)	A minimum of two water tube boilers each sized for 100% of the building capacity and on emergency power.

AHU preheat coil pump	One in-line pump per air handling unit, on emergency power.

3.2.4 Chilled Water

A. Introduction

Chilled water is the means by which heat is rejected from the building to the outdoors. Normally, heat from lighting fixtures, people, equipment and solar radiation is transferred to the chilled water system through various heat exchange devices located throughout the building. Since the vivarium portion of the building requires 100% outside air, all ambient heat is rejected at the air handler. The additional heat gained within the vivarium will be removed by the 100% exhaust system. Rejected heat at the air handlers and exchangers is then removed from the building through chilled water return lines leading back to the chilling source. The chiller, through the use of refrigerants, re-cools the water and the chilled water is returned to the building to begin the cycle again. The chiller must at the same time reject the heat to the atmosphere through either an air cooled or water source method.

B. Background

To meet the 24 hour/365 day chilled water needs of the vivarium, chilled water typically in the range of 42 degrees, must be delivered to the building and distributed to the various air handlers to maintain interior environmental conditions. Discharge air temperatures from the air handlers ranges from 50-52 degrees. Chilled water is also delivered to the process water loop, if required. The process water loop is used to reject heat from equipment such as environmental rooms, autoclaves and other miscellaneous high heat producing equipment that requires chilled water at 60 degrees in lieu of the typical 42 degrees. Typically, the process water loop is separated from the chilled water loop by a plate and frame heat exchanger. Process water side pumps should include a redundant pump with all pumps being on emergency power.

Return temperatures from the building shall be at least 14 degrees warmer than chilled water supply during peak, or greater if returning to TECO. The AE consultant must verify the design requirements of the existing system providing the chilled water. Generally, higher chilled water temperature deltas are recommended at the Main Campus air handling unit coils to reduce the GPM (gallons per minute) flow required by the building. This allows reduced pipe size, pump size, energy use and reduced GPM requirement from TECO. Where central utility provides chilled water to secondary pumps serving a one story building or low rise portion of a high rise building or heat exchangers located at the lower levels, a bypass shall be provided around the pumps to allow pumping from the main utility pumps during light load conditions.

Chilled water distribution piping is generally schedule 40 black steel sized for 2 to 3 ft friction loss per 100 feet of pipe. Where feasible, copper may be substituted for smaller branch lines. Piping shall be no smaller than %".

C. Data

Based on shared experience between user, builder, designer and maintenance provider, the following elements listed in the table below should be used in designing an UT HEALTH vivarium.

D. Standard

Chilled Water System Requirements

Building chilled water pumps and process water pumps	Horizontal splitcase pumps, minimum 2 pumps each sized for 100% capacity and on emergency power. Pumps shall be provided with VSD, isolation valves, strainer, check valve, flex connectors and housekeeping pad (inertia pad where required). Typical for plant, building primary or secondary chilled water pumps as applicable.
Distribution piping-Chilled and Process water	Piping shall be schedule 40 black steel. Small branch lines may be copper where feasible. Where chilled water piping also serves the high rise portion of the building, the A/E team shall investigate need for 150 PSI versus 300 PSI class fittings. Dielectric unions shall be provided where dissimilar metal come in contact.
Isolation valves	Provide chilled water supply and return isolation valves at TECO entrance, bottom of each riser, each floor take-off from riser and each piece of equipment.
Air Cooled Chiller (where applicable) Water cooled chiller and cooling tower (where applicable)	A minimum of two chillers each sized for 100% capacity and each on emergency power.
Building chilled water and process water plate and frame heat exchangers (where applicable)	A minimum of two heat exchangers each sized for 100% capacity shall be provided.
Entire chilled and process water systems serving vivarium space and equipment	Completely on emergency power along with associated controls.

E. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-16, 17 and 18.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

3.2.5 Supply Air & Filtration A. Introduction

Supply air to the vivarium and associated support areas shall be of the best quality. Generally vivaria will require 100% outside air once through cooling. Support office areas where feasible shall be provided with a re-circulating type system. The 100% outside air from its
introduction into the building, conditioning process, distribution and final dispersion into the various vivarium rooms, require significant consideration by the AE consultant. The supply air introduced into the vivarium shall be taken from the outdoors at points in the building that are free from contaminants such as vehicular emissions, sewer gases, boiler gases and lab exhaust. Wind studies shall be performed through the AE consultant prior to the design phase, to verify the selected vivarium intake area will be free of hazards when modeled for the various seasonal wind currents.

B. Background

As the air is drawn into the building through louvers, velocities shall remain low to eliminate any chance of wind drawn rain into the building and ultimately air handling unit prefilters. To maintain the 24 hour/365 day a year 52-55 degree supply air environmental requirements of the vivarium, each 100% outside air handling unit shall consist of an intake plenum, isolation damper (as needed), 30% prefilter, preheat coil (energy recovery if required), clean steam humidifier, cooling coil, fan section, sound attenuator (as needed), 90% final filter, HEPA filter (as needed), discharge plenum, isolation damper and variable speed drive. Multiple air handlers manifolded together shall be provided for the vivarium air quantity requirement, including partial redundancy in order to meet environmental conditions with one fan out-of-service. The AE consultant when designing the system shall build into the design and selection of air handling unit equipment, component failures, emergency air reduction measures and automated control sequences that maintain the environmental conditions of the animals at all times. While maintaining supply air to animal areas for environmental conditions is of most importance, the AE consultant shall also be cognizant of ultimately maintaining pressure gradients across barrier and biohazard areas. In the event pressure gradients cannot be maintained, the design and control of the supply air along with the exhaust air shall be coordinated so that all spaces at minimum remain neutral.

The supply air shall be distributed from the air handler to the vivarium spaces through galvanized ductwork designed to minimize noise transmission into the vivarium spaces during both normal operations and start-up/shut-down sequences and minimize energy losses associated with poor duct distribution or construction. Individual room supply air control shall be maintained by pressure independent terminal units outfitted with reheat coils to maintain temperature control. The terminal unit maintains a constant air quantity to the room to maintain air change rates while the reheat coil maintains space temperature. The terminal unit shall be capable of multiple air quantity set points to accommodate positive, negative or zero air flow (as would be required by sanitization of the animal room). Terminal unit upsizing generally will minimize the noise transmission into the rooms. Although not preferred, some applications may require an additional sound attenuator for noise control. Low pressure galvanized ductwork from the terminal unit to the dispersion air device shall be selected to minimize air noise transmission into the animal room.

Dispersion of supply air into the room shall be studied by the AE consultant to determine the most effective distribution. In the animal holding rooms, supply air distribution is of utmost importance. Generally the supply air is distributed from the center of the ceiling to maintain even flow across the room to avoid cold or drafty spots. Radial flow diffusers provide even supply air distribution in animal related rooms. Louvered face diffusers are effective in all other support spaces, but should be evaluated on an as needed basis by the AE consultant. Radial face supply air diffusers should be provided at biological safety cabinet and fume hood locations to avoid disturbance of hood face velocity flows.

C. Data

Based on shared experience between user, builder, designer and maintenance provider on past projects, the following elements listed in the table below should be used in designing an UT HEALTH vivarium:

D. Standard

Supply Air, Conditioning, Filtering and Distribution Requirements	
Item	**Direction**
Outside Air	
Air quality at intake location	Wind study
Intake louver sizing	Less than 500 FPM
Conditioning Air Handling Unit (AHU)	
Intake plenum	Size for smooth transition into filter section at low velocity.
AHU intake isolation (if needed)	Opposed blade damper
Pre filter	Minimum 30%
Access sections	Required between coil banks
Heating coil	Maintain 45 degree @inter
Humidifier	Maintain 50% relative 31 inter
Cooling coil 1 pre cool	Maximum 450 FPM
Cooling coil 2 final cool	Maximum 450 FPM @2-56
Supply fan	Direct drive plug type
Final filter	Minimum 90%
HEPA filter	Verify requirement
Discharge plenum	Size for effective filtration
Discharge isolation damper	Used for unit shutdown

Variable speed drive	Control filter loading
Distribution Ductwork	
Supply low/medium pressure duct	Galvanized (externally insulated)
Duct sizing for low/medium pressure duct	Size duct to minimize air noise, avoid pressure losses.
Duct construction for low and medium pressure duct	Use round duct where possible or reinforce to avoid duct flexing during system shutdown/startup.
Animal holding, animal suite corridors, procedure, necropsy, surgery and lab - pressure independent terminal unit device for each room	Tracking supply valve with reheat to include 4 preset air quantities capable of positive or negative control while maintaining room offsets. Also provide with 100% shutoff control and constant volume in animal areas. Fail position shall be last position. Valves similar to Phoenix type system.
Cage wash, storage, support areas, support area corridors and office area - pressure independent terminal unit device for each room. Multiple offices or rooms with similar requirements can be served from one terminal unit (not to exceed 4 offices).	Variable air volume supply air valve with reheat. Similar to Titus industries units. Internal insulation shall be lined.
Room Distribution Device	

Animal, procedure and lab hood room air device	Flush face radial air distribution design.
All support areas	Flush louvered or perforated face diffusers.

E. References

ASHRAE Handbook - Fundamentals. 2005. Chapter 16-Airflow Around Buildings

ASHRAE-Applications Handbook. 2003. Chapter 14-Laboratories, Chapter 44-Building Air Intake and Exhaust Design.

NFPA 45-Standard on Fire Protection for Laboratories Using Chemicals. 2004. Complete

3.2.6 Ventilation & Air Change Rates

A. Introduction

According to the Guide for the Care and Use of Laboratory Animals (National Research Council, 1996), the guideline of 10 to 15 fresh-air changes per hour has been used for vivarium room envelopes for many years and is considered an acceptable general standard. The purposes of ventilation which manifests itself in the form of room air change rates are to:

1. Supply adequate oxygen;
2. Remove thermal loads caused by animal respiration, lights, equipment and personnel;
3. Dilute gaseous and particulate contaminates and control odors;
4. Adjust the moisture content of room air and;
5. Create static-pressure differentials between adjoining spaces.

B. Background

Even though calculations can be used to determine minimal ventilation needed to prevent heat buildup, other factors such as odor control, allergen control, particle generation and control of metabolically generated gases might necessitate ventilation beyond the calculated minimum for heat load. In addition, the method of animal cage ventilation, the operational use of a fume hood or a BSC during procedures involving animal cage cleaning and animal examinations should also be considered. In general, the recirculation of air in a vivarium is prohibited. Typical animal holding and procedure rooms from UT HEALTH's BSRB vivarium were modeled and used for the basis of ACR calculations. The assumptions and results of these calculations are provided in Appendix 8.1 and 8.2. The calculations indicate that the small animal holding room's heat load required an ACR of approximately 6 air changes per hour while the larger, more equipment driven procedure room required approximately 10 air changes per hour. These ACR calculations only account for heat load and do not address the other factors such as odor control, etc.

Vivarium spaces must be protected against contamination from outside sources. In some instances, high-efficiency particulate air (HEPA) filters are recommended for air supplied to animal-holding, procedural and surgical facilities. Also, consideration should be given to the regulation of air-pressure differentials in surgical, procedural, housing and service areas. For example, areas for quarantine, housing and use of animals exposed to hazardous materials should be kept under negative pressure; whereas areas for surgery, for clean equipment storage and for housing of pathogen-free animals should be kept under positive pressure with clean air. The HVAC system must be adaptable so that pressure relationships can be modified as required over the life of the facility.

C. Data

A study was done by UT UT HEALTH Facilities and DVMS departments seeking a consensus of opinion regarding minimally acceptable air change rates from reputable and well-known owner / operators of facilities housing animals used in research. Based on information gathered and reviewed by members of the ARSAC Design Standards Subcommittee, the following table of air change rates is presented as representing the consensus of opinion found. The rates given, therefore, comprise the minimum acceptable building air change rate settings for the various small animal rodent vivarium areas:

D. Standard

Acceptable Minimum Air Changes Per Hour (ACH) By Room Type	
Animal Housing (100% ventilated cage racks)	10
Animal Housing (any number of static cage racks)	15
Procedure Rooms	10
Washroom	40 occupied / 20 unoccupied
Autoclaves	40 occupied / 20 unoccupied
Support (clinic, cryogenics, irradiator, x-ray, etc.)	10
Necropsy	15

E. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-16, 17 and 18.

UT UT HEALTH, Internal Study and Report, April, 2005. Air Change Rate Recommendations for Mitchell BSRB Vivarium. Mike Green, Study Group Chair.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

3.2.7 Exhaust & Filtration

A. Introduction

Exhaust air from the vivarium and associated support areas shall exit the building at or near the highest part of the building and away from any fresh air intakes. The exhaust fan locations should be evaluated by the A/E Team to minimize noise and odor levels at the street level. Wind studies shall be performed by the NE consultant prior to the design phase. Generally, separate biohazard/radioisotope exhaust and general exhaust systems suffice; however in larger vivaria the systems should be divided into cage wash, biohazard, radioisotope (RI) and general exhaust systems to minimize duct riser sizes up through multistory buildings.

B. Background

The vivarium exhaust systems serve multiple space types. Generally, toilet, janitor closet, animal holding, animal holding corridor, procedure room, cage wash, sterilization, storage, bedding storage and lab exhaust is considered general exhaust. B1 biological safety cabinet and chemical fume hood exhaust shall be included in the general exhaust system. B2 biological safety cabinet and radioisotope hood exhaust shall be routed to the combined biohazard/radioisotope exhaust fan system. In some cases, the biohazard and radioisotope exhaust have a separate exhaust fan system as well as separate filtration requirements. The animal biohazard general exhaust system shall support all biohazard animal holding rooms, quarantine and necropsy. If there are research-specific exhaust filtration requirements, they should be established early in the programming phase.

All fan systems shall operate 24 hours/365 days a year. Each fan system shall include an intake plenum, sound attenuator (as needed), fan, individual exhaust fan isolation, bypass damper and discharge at least 15'-0" above the roof. Exhaust discharge velocity shall not be less than 3000 FPM (feet per minute) with 3500 FPM preferred. Multiple fans grouped/manifolded together shall make up the exhaust requirement for each fan system. The AE consultant when designing the system shall build into the design and selection of the fans, component failures, emergency air reduction measures and automated control sequences that maintain the environmental conditions of the animals at all times. Ultimately, the AE shall be cognizant of maintaining pressure gradients across barrier and biohazard areas. In the event pressure gradients cannot be maintained, the control of the exhaust along with the supply air shall be coordinated so that all spaces at minimum remain neutral.

The exhaust air ducts from the vivarium spaces to the exhaust fans shall be designed to minimize noise transmission and energy losses associated with poor duct distribution or construction. Individual room exhaust air control shall be maintained by pressure independent terminal units. The terminal unit maintains a constant air flow and tracks the supply air terminal unit to maintain the vivarium spaces positive or negative as required by the program. The terminal unit shall be capable of multiple air quantity set points to accommodate positive, negative or zero air flow (as would be required for sanitation of the animal room). Terminal unit upsizing generally will minimize the noise transmission into the rooms. Although not preferred, some applications may require an additional sound attenuator at the terminal unit. Low pressure galvanized ductwork from the room exhaust device to the terminal unit shall be sized to minimize air noise transmission into the animal room.

The exhaust air devices in animal holding rooms shall consist of a series of thimbles and exhaust grilles. The thimbles penetrate through the ceiling to receive the exhaust duct from the ventilator racks but can also be used as general exhaust directly from the animal room when static cage racks are used Generally, up to two racks can be accommodated by one thimble. An additional general exhaust grille shall exhaust the additional air required by the room air change rate requirement. In the animal rooms, the thimbles and general exhaust grille are located in the ceiling and served by one terminal unit. In procedure rooms, generally one thimble is provided to receive a ventilator rack and shall be provided with a dedicated terminal unit. All other exhaust air devices shall be standard perforated face or louver type grille.

C. Standard

Exhaust Air, Filtering and Distribution Requirements

Item	Direction
Exhaust Air Dispersion	
Exhaust Air dispersion location	Highest roof level. Provide wind study
Minimum dispersion velocity. FPM (feet per minute)	Minimum 3000 FPM, 3500 FPM preferred minimum
Minimum exhaust discharge height above roof	15'-0"
Typical Exhaust Fan System	
Exhaust fan discharge	Provide high velocity nozzle.
Exhaust fan discharge sound attenuator if required	Confirm requirement with sound consultant.

Fan isolation	Provide individual automatic fan isolation with stainless steel or aluminum damper construction.
Fan motor	Direct drive with vibration cutout switch.
Fan system type	High plume and high velocity laboratory exhaust systems as manufactured by Strobic Tri-stack.
Number of fans in fan set.	2,3,4 or 6 fan sets. Each fan set shall require one backup fan.
Fan intake plenum (double wall with stainless steel internal liner).	Double wall plenum sized to accommodate all exhaust fans.
Plenum intake velocity range	Between 900 —1200 FPM.
Bypass damper.	Minimum of two per system.
Biohazard and Radioisotope Filtration	Depends on agents used. Contact EH&S for exact filtration requirement
Filter inlet and outlet isolation	Bubble tight damper.
Filter Caisson construction	304 stainless steel
Filter Caisson	Provide 1 redundant unit for each filter set required.
Prefilter efficiency (bag in/bag out)	30% pleat

Final filter	99.97 % HEPA
Prefilter/final filter maximum velocity	400 FPM.
Charcoal filter media	Coconut shell carbon in stainless steel trays.
Charcoal filter residence time	No less than .25 seconds. Size caisson accordingly.
Distribution Ductwork	
Duct sizing for low/medium pressure duct.	Size duct to minimize air noise, avoid pressure losses.
Duct construction for low/medium pressure duct.	Use galvanized round duct where possible or reinforce to avoid duct flexing during system shut-down/startup.
Animal holding, animal suite corridors, procedure, necropsy, surgery, cage wash and lab — pressure independent terminal unit device for each room.	Tracking exhaust valve to include 4 preset air quantities capable of positive or negative control while maintaining room offsets. Also provide with 100% shutoff control and constant volume in animal areas. Fail position shall be last position. Valves shall be similar to Phoenix type system.

Storage, support areas, support area corridors and office area — pressure independent terminal unit device for each MOM.	Variable air volume exhaust terminals shall be equal to Titus Industries. Match supply air room grouping.
Biohazard B2 cabinets and radioisotope hood ductwork	Welded 304 stainless steel from BSC/hood to exhaust fan plenum.
Room Exhaust Device	
Ventilated cage rack exhaust for procedure rooms and animal holding rooms	Provide one 6" drop to receive thimble for every two racks. Single racks will also require one 6" drop for thimble.
Animal holding and procedure rooms	Painted stainless steel perforated face or louvered grille.
All support areas	Painted steel perforated face

D. References

ASHRAE Handbook - Fundamentals. 2005. Chapter 16-Airflow Around Buildings,

ASHRAE-Applications Handbook. 2003. Chapter 14-Laboratories, Chapter 44-Building Air Intake and Exhaust Design.

NFPA 45-Standard on Fire Protection for Laboratories Using Chemicals. 2004. Complete

3.2.8 Control Systems

A. Introduction

The building mechanical systems include some of the largest as well as the majority of the equipment serving a vivarium. The heating, ventilation and air conditioning system (HVAC) represents the majority of the mechanical equipment. The HVAC system continuously maintains air flow, air cleanliness, temperature, humidity, odor transmission and containment. It is for this reason that the HVAC control system is tasked with monitoring the plumbing and electrical systems, monitoring user critical equipment and controlling and monitoring the HVAC systems. Through the individual system sensors and controllers, the building automation system (BAS) must automatically react to continuous temperature changes and sudden system failures to maintain the required vivarium and vivarium support space environmental conditions. Fire protection, elevators, communication systems and security system are not controlled or monitored by the BAS, although the fire protection system does provide control interface to some HVAC systems to shutdown or energize in case of fire or smoke.

B. Background

Most UT HEALTH buildings are controlled and monitored through the existing Siemens Apogee building automation system. The building automation system in new buildings shall accommodate the existing system infrastructure and accomplish building control and monitoring functions through direct digital control (DDC), regardless of vendor. The system architecture includes the master building controllers (MBC) provided to interface and monitor modular equipment controllers and application specific controllers. Modular equipment controllers (MEC) will provide control and monitoring of systems through system devices, as well as specific points such as critical alarms. Application specific controllers (ASC) provided for control and monitoring of packaged equipment, typically not Siemens, are monitored by the MBC. Communication between controllers shall occur through Ethernet communication protocol. The building shall be monitored and controlled locally at the building operator work station or other approved EH&S work stations and monitored remotely at UT HEALTH/EH&S Monitoring Services. All AC power to the BAS controllers shall be on emergency power. The need for uninterruptible power systems (UPS) for the various controllers shall be evaluated by the AE, conformant to the requirements of the various spaces. Typically the controller and the system equipment should be on the same power source, however if this is not possible,
the equipment sequences shall be designed to incorporate loss of power, power transfer, equipment failure and initiation of redundant equipment scenarios. Maintaining pressure relationships during power failures is one of the main considerations.

The BAS system including all component devices and controllers shall maintain memory during power losses, restart quickly after power failure, have high speed communication, be capable of supporting GLP (Good Laboratory Practices) quality verification, include accurate graphic representation of the various systems and allow for system trending. The BAS components shall be of the latest manufacturer generation at the time of submittal, but shall be of tested and proven design and reliability. The BAS system shall exchange information with other specialized control systems such as the Edstrom Watchdog system which controls and monitors animal room lighting and watering and receives temperature and humidity conditions from the Siemens system. The Phoenix air tracking system will also be interfaced with the Siemens BAS system to send temperature, airflow and alarm conditions for each zone.

C. Data

Based on shared experience between user, builder, designer and maintenance provider on past projects, the following elements listed in the table below should be used in designing an UT HEALTH vivarium.

D. Standard

General Control System Highlights	
Item	**Direction**
Building Automation System	Siemens Apogee unless otherwise directed by the EH&S Director, in
Typical animal holding room controller	1 stand alone controller per room (1 additional misc. space can be in-
Typical animal holding room alarms	Low/high temp, lighting level, low/high room pressure differen-
Typical user critical equipment alarm to	Environmental rooms, incubators, freezers, LN2 freezers, etc.
Typical equipment alarmed locally at	B1 & B2 biological safety cabinets and fume hoods
Typical systems using application specific controllers, although Sie-	Control air, vacuum, RO, water softener, domestic water pumps, clean
Application Specific Controllers provided by packaged equipment	Provide dry set of contacts for connection to BAS to pick up general alarm, plus allow for pick up of indi-
Control valve and damper actuators	All electric

E. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.
National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-16, 17 and 18.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

3.2.9 Animal Drinking Water

A. Introduction

A normal rodent drinks approximately 0.1 ml of water per gram of body weight daily. In older caging systems, water is provided via glass or plastic water bottles that fit on the wire bar lid of the cage. A standard mouse drinking water bottle contains 250m1 and rat bottles 500m1. Water bottles must be changed at least as often as the cage, if not more often depending on the size and condition of the animal. Water bottles must also be changed at least weekly to prevent the formation of bio-film. An automated drinking water system allows for a constant supply of fresh drinking water without the need for water bottles. Care should be taken in the design to avoid malfunctions which lead to flooded cages and, conversely, obstruction of water flow.

B. Background

The National Research Council (NRC) Guide indicates animals should have access to potable, uncontaminated drinking water. Also, water quality and the definition of potable water can vary with locality. Periodic monitoring for pH, hardness and microbial or chemical contamination may be necessary to insure water quality is acceptable. Water can be purified and/or treated to minimize or eliminate contamination when protocols require highly purified water. The selection of water treatments should be carefully considered because many forms of water treatment have the potential to cause physiologic alterations or effects on experimental results.

In most UT HEALTH applications, the domestic/potable water quality will require both water softening to reduce mineral hardness and then further water purification, usually by reverse osmosis (RO) to provide water of the required level of purity for laboratory research and animal drinking water use.

Special attention should also be placed upon the high purity water distribution system piping connections and integrity. At the Mitchell BSRB, UT HEALTH has experienced continued leaking joints in the polypropylene RO water piping system since the building construction was completed. Many joints and connections are no longer accessible causing significant building damage when joints and connections fail and begin to leak. The failures at that project have been attributed to difficult-to-use electrical joint fusing machines and operator errors during initial installation.

C. Standard

Drinking water is distributed to animal cages via a stainless steel distribution system composed of two separate pipes: one for delivery of fresh drinking water and one for disposal of flush waste water. Clean drinking water from the source point is delivered to the pressure reducing station (PRS) via appropriate piping material. From the PRS, all distribution piping is stainless steel to the cage rack connection points and waste flush termination. At each cage rack position, there is a recoil hose from the delivery pipe to the cage rack inlet on the rack manifold. From the terminal end of the rack, a recoil hose connects to the flush piping which discharges into a sink or floor drain (waste flush water is discarded, never re-circulated). The animal drinking water system should be computer controlled to allow for user-defined flush schedules. The system must generate alarms for abnormal conditions, such as prolonged flow, flush failure, pressure problems, etc., with user-defined alarm and notification
parameters and schedules. Notification methods include phone call, email, paging, and critical alarming to the Building Automation System.

See Appendix 8.3 for the following detailed sections on the Animal Drinking Water System:

1. Stainless Steel Room Distribution System
2. Pressure Reducing Station 3. Reverse Osmosis System 4

Recoil Hose Flush Station

5. Chlorine Injection Station
6. Rack Manifold Flush Station

3.2.10 Bedding Delivery & Removal

A. Introduction

The rodent colony uses bedding at a rate of approximately 8-10 ounces of clean bedding per processed cage each day. Soiled bedding is generally at least 1.25 times heavier than clean bedding. For example, the current (as of 3/21/07) census of 15,000 cages has a daily cage change rate of 3,000 cages. At this rate, 1,500-1,875 pounds of clean bedding and approximately 1,875-2300 pounds of soiled bedding are processed each normal work day. As the colony grows, the washroom must become more efficient in terms of staff time The vacuum bedding system allows for maximum efficiency on both the clean bedding delivery side and the soiled bedding removal side.

B. Background

Prior to the advent of automated bedding delivery and removal systems, bedding was received as pallets of 50 40lb bags. Clean bedding delivery was accomplished by manually dumping each bag into the bedding dispenser, which could average as much as 5 minutes per bag., The hopper only holds approximately 2-3 bags' worth of bedding, so manual filling was required quite often. Given the amount of bedding used each day, this task could require up to 0.5 FTE each day. The automated system uses ½ ton bulk bags, out of which the bedding is vacuumed via a wand into the storage silos and requires approximately 10-15 minutes per bulk bag. At a rate of 2 bulk bags (the equivalent of 50 401b bags), this requires less than 0.1 FTE per day. As the bedding dispenser requires clean bedding, the system conveys the clean bedding directly from the storage silo to the dispenser.

On the soiled side, cage waste was previously dumped into a rolling dumpster that could only be filled to ^{3}/, full so that the compactor cart lifter could handle it. The dumpster then had to be rolled up to the institutional waste compactor which could take as much as 30 minutes per trip. Given the amount of cage waste generated each day, at least 4 trips to the dumpster had to be made, requiring up to 0.5 FTE each day. The automated system uses a dump station, into which the bedding waste is dumped. The waste is conveyed from the dump station directly to a dedicated waste container, thus requiring 0 FTE.

C. Standard

Clean Bedding Delivery Requirements	
Item	**Direction**
Filling	Both wand for bulk bags and dump station for bags must be provided. The con- panel should be located so that it is conveniently reached by either filling area.
Storage and delivery	All components should be 304 stainless steel. Filling funnel should have a drain trap to facilitate rinsing.

Storage silo	Provide storage for 2.0 to 3.5 cubic yards of bedding material. Silo should have alarming capabilities for high and low bedding levels. Silo interface with delivery piping must be optimized to prevent eddying or dead space.
Bedding dispenser interface	The bedding dispensers' storage hoppers must have level sensors to indicate a full/not full bedding level and automatically replenish the bedding volume. A control panel for the clean bedding delivery system should be located near the bedding dispenser storage hopper.
Delivery piping	Readily accessible cleanouts must be provided at reasonable intervals to facilitate cleaning and servicing. Piping must be routed with minimal bends and turns.
Soiled Bedding Collection Requirements	
Item	**Direction**
Collection & delivery piping	Must be constructed of 304 stainless steel. Readily accessible cleanouts must be provided at reasonable intervals to facilitate cleaning and servicing. Piping must be routed with minimal bends and turns.
Waste Collection Funnel	The waste collection funnel should have a drain trap to facilitate rinsing. It should be positioned at the load end of the washer in the most ergonomically feasible location.
Controls	The waste collection control panel should be located near the waste collection funnel.

D. References

Project Manual, South Campus Vivarium, GMP-2 100% Construction Document Submittal

3.2.11 Cage Wash and Sterilization

A. Introduction

Cage washing and sanitation is the backbone of the animal care program. Proper sanitization and, where applicable, sterilization is of paramount importance in maintaining colony health and well being, as well as personnel health and safety.

B. Background

Washing times and conditions should be sufficient to kill vegetative forms of common bacteria and other organisms that are presumed to be controllable by the sanitation program. When hot water is used alone, it is the combined effect of the temperature and the length of time that a given temperature (cumulative heat factor) is applied to the surface of the item that disinfects. Effective disinfection can be achieved with wash and rinse water at 143-180˚F or more The traditional 82.2˚C (180˚F) temperature requirement for rinse water refers to the water in the tank or in the sprayer manifold. Because of the nature of the research, chemicals are not used. Hot water alone is relied upon to effectively sanitize equipment.

Conventional methods of cleaning and disinfection are adequate for most animal-care equipment. However, if pathogenic microorganisms are present or if animals with highly defined microbiologic flora or compromised immune systems are maintained, it might be necessary to sterilize caging and associated equipment after cleaning and disinfection. Sterilizers should be regularly calibrated and monitored to ensure their safety and effectiveness. Hazardous waste must be rendered safe by sterilization, containment, or other appropriate means before being removed from the facility (US EPA 1986)."

C. Standard

Cage Rack Type Washer Requirements	
Item	**Direction**
Seven phase	Pre-wash, wash, 2nd wash (alkaline or acid), soak, first rinse, second rinse, final rinse, exhaust/dry
Temperature guarantee	180°F guarantee on wash and rinse phases, with visual and audible alarm-
Chamber construction	All stainless steel
Chamber Size	Chamber: 46" wide x 87" long x 87" high
Pit Size	Minimum 86" wide x 101" long x 6" deep, nominal, to be coordinated with equipment. Washer chamber to align with finished floor. Drain location coordinated with equipment.
Microprocessor Control	Controls to be programmable by end user and password protected.

Tunnel Type Washer Requirements	
Item	**Direction**
Five phases / Sections	Pre-wash, wash, re-circulated rinse, final rinse, dryer
Temperature guarantee	180°F guarantee on wash and rinse phases, with visual and audible alarming
Chamber construction	All stainless steel

Conveyor	36" wide stainless steel roller-type, gravity- type with corrosion free bearings and shafts. Belt speed to be adjustable from 2-10 feet per minute. Photoelectric eye at discharge end to automatically stop belt when an item reaches the end, with a visual and audible alarm for a stopped condition.
Dryer	99% plastic cage drying
Microprocessor Control	Controls to be programmable by end user and password protected.
Sterilization Requirements	
Item	**Direction**
Cycles	Allow for general purpose steam sterilization of unwrapped equipment, wrapped instruments and utensils, and liquids in vented or unsealed containers at temperatures ranging from 105C — 135C (220°F - 275°F).
Temperature uniformity	Within chamber, A- 18C during cycles.
Microprocessor controls	Control all system functions, monitor system operations, visually and audibly alert operator of cycle malfunctions and on command visually indicate chamber temperature and pressure. Control system to be compatible with PC/DOS support software.
Non-operating end controls	Consists of only door operations, chamber pressure gauge, emergency stop, and displaying process conditions. Mount in the fascia on the unload side of the sterilizers opposite the door.

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. pg 43-44.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities.

3.2.12 Monitoring Instrumentation

A. Introduction

Fluctuations in environmental conditions can compromise animal health and well-being. Design standards exist that define the acceptable ranges for these conditions, but there must be a way of ensuring that conditions remain inside the acceptable range for the following parameters:

1. Temperature
2. Humidity
3. Differential pressure
4. Actual supply and exhaust air flow rates 5. Air change rate (air changes per hour)

B. Background

Regular monitoring of the HVAC system is important and is best done at the individual-room level. All monitoring devices must communicate with an electronic system that records measurements at regular intervals. A separate, independent Vivarium Management System (VMS) capable of monitoring temperature and relative humidity is preferred in order to provide confirmation of room environmental conditions. The system should allow for easy manipulation of point logging intervals, alarm parameters, alarm notification structure, and other critical elements. The VMS provides the animal facility management staff instant access to critical environmental information as well as reports designed to meet regulatory requirements. An open protocol will allow for information to be shared across platforms (i.e., Building Automation System (BAS) and VMS so that BAS information (air flow, differential pressure, etc.) can be incorporated into VMS reporting.

C. Standard

Parameter	Monitoring Device Requirements
Temperature & Relative Humidity	1. Monitor devices located within the room, not the ductwork 2. Stainless steel, watertight housing enclosure 3 Guard to protect sensor probes 4 NIST traceable sensors 5. Temp sensor: 100 OHM platinum thin-film RTD 6. Humidity sensor: interchangeable capacitive element with filter 7. Calibrated accuracy to within A-1°F & A-5%RH 8. Temperature range 0-120°F (-18 — 49C) 9. Humidity Range 20-85%RH
Differential Pressure	4-20 MA Current Loop
	1. Pressure range: 0.0 to 40.1 0.0 40.25 inches of water column bi-directional 2. Accuracy 43% full scale 3. 4-20 MA linear output
Air flow	Duct mounted sensor

	1. Size to provide a single monitoring point near the center of the duct cross sectional area 2. Mounting hardware: stainless steel 3. Sensor: PVC plastic 4. Air tight installation 5. Transducer 6. 4-20 MA Current Loop 7. Calibration accuracy CFM A-10% 8. Pressure range 0--.1, 0-.025, and 0-0.5 inches of water column unidirectional set to 65% scale at design of air supply flow 9. 4-20 MA current loop to panel analog input 10. Connection to sensor with flexible PVC twin tubing; barbed connections

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Pg. 75.

3.2.13 Sequence of Operations

A. Introduction and Background

The interaction of the operation of the vivarium mechanical and electrical equipment is monitored and controlled by the building automation system (BAS). How the BAS controls the equipment is defined in instructions and contingency plans defined in the pre-established building controls program. The control functions are defined by way of system logic diagrams that are based upon the design team's expected sequence of operations for various facility operational conditions.

The vivarium design team must specify the logic of equipment sequence of operations. In many cases, the sequence of operation is specified only in general, and often ambiguous, terms with much of the sequence left to the Contractors controls programmer. The controls programmer should not be put in the position of having to complete the design sequence which often results in sequences which are not optimal or desired for the project. Therefore, logic diagrams must be included in design documents provided by the design team and approved by The University. To assist the design team with this, UT HEALTH provides design guideline and master specification documents that help define functional intent of the system operation.

B. Data

In developing the sequence of operations logic, the design team must consider the following range of facility operational conditions:

1. Normal Operations (Start/Stop Permissives and Interlocks)
2. Loss of Normal Power (Re-Start on Emergency Power)
3. System Safety Interlocks
4. Equipment and Component Failure Modes
5. N-1 Operational Contingencies (Redundancy with Single Failure)
6. N-2 Failure Curtailment Strategies (System Unable to Operate at Full Load)
7. Critical Alarms
8. Maintenance of Room Pressure Relationships during Upset Conditions C. Standard

In all cases, the vivarium design team is responsible for identifying and documenting the sequence of operation for the facility early in the project's design life. This design information must be prepared with input from UT HEALTH and must be reviewed and agreed upon prior to the preparation of Construction Documents by the design team.

Sequence of Operations	
Identify Possible Failure Modes	Design Team
Identify Expected Levels of Re-	Design Team and UT HEALTH
Preparation of Logic Diagrams	Design Team Using UT HEALTH
Prepare Detailed Sequence of Op-	Design Team

Review and Accept Sequence of Operations UT HEALTH as Owner and End User

3.2.14 Waste Disposal

A. Introduction

Types of waste generated within the animal facility include conventional, biological, and hazardous. Waste should be collected in leak-proof containers with tight fitting lids and disposable liners. Adequate staging and storage space must be provided within the facility footprint to accommodate the accumulation of waste during the normal work day. Storage of collected waste in corridors is not desirable. Storage rooms should be free of feral and/or loose rodents, insects, and other vermin. Care must be taken during design to ensure that adequate waste stream management space is included.

B. Background

Non-hazardous, conventional waste can be disposed of as regular institutional waste and taken to an approved landfill by the institution's waste collection contractor. Biological waste must be rendered safe by sterilization, containment, or other appropriate means before being removed from the facility (US EPA 1986). Infectious waste, including animal carcasses, is placed in an acceptable biohazard bag inside a biohazard box, which is collected by a licensed contractor and removed to an incineration facility. Radioactive waste must be collected, contained appropriately, and stored in a dedicated room for the duration of the radioactive decay period as appropriate for the radioisotopes involved.

C. Standard

Waste Disposal Requirements	
Item	**Direction**
Conventional	Landfill by approved institutional con-
Biological	Rendered safe by sterilization and contained before removal
Infectious	Bagged and boxed before incineration by outside contractor
Radioactive	Contained and stored in separate room during applicable decay period prior to disposal by qualified contractor

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. pg 45.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities.

3.3 Redundancy Requirements 3.3.1 General Information

A. Introduction

Research animals cannot easily be relocated for a myriad of reasons including, but not limited to, colony size, health status, cage type, and time constraints. Thus, animal housing facilities must remain operational at all times, i.e., normal environmental conditions which pose no health hazard to the animals. Redundant mechanical and electrical systems must be provided to ensure uninterrupted service for the following areas:

1. Environmental control — temperature, relative humidity
2. Differential pressure (room to suite, suite to corridor, etc.)
3. Animal housing sanitization equipment (cage washers)
4. Equipment decontamination and sterilization equipment (autoclaves)

B. Background

Mechanical systems that serve animal housing and use areas must be able to maintain required conditions during both planned and unplanned outages. For example, an air handing unit may be equipped with three fans each able to provide 50% of the CFM capacity. If one fan is down for any reason, the other two fans are able to provide 100% of the required CFM. The institution recognizes, however, that this is just one method in which to accomplish the goal of redundancy.

According to the National Research Council Guide, when a partial HVAC system failure occurs, systems should be designed to supply facility needs at a reduced level. It is essential that life-threatening heat accumulation or loss be prevented during mechanical failure. Acceptable reduced levels for areas requiring uninterrupted service are defined in each specific Design Standard (e.g., ventilation rates, environmental conditions, bio-containment, etc.).

American Society for Heating, Refrigeration, Air Conditioning Engineers (ASHRAE) states that animal room conditions must be constantly maintained. This may require year round availability of refrigeration and, in some case, dual/standby chillers and emergency electrical power for motors and control instrumentation.

The National Institute of Health outlines in its Vivarium Design Policy and Guidelines — without exceptions - HVAC systems must be reliable, redundant, and operate without interruption. Since most animal studies are of long duration, they must be performed under consistent conditions in order to achieve repeatable results. Thus, the failure of the HVAC system is unacceptable. Therefore, the HVAC system must be designed to provide backup in the event of component failure. Central HVAC systems thus should be provided with multiple chillers, pumps, cooling towers, etc. to improve reliability."

C. Standard

Standards for redundancy will depend on the building project requirements. The AE consultant is expected to provide the most cost effective method for providing uninterrupted service based on the specific project.

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Pg. 76.

1999 ASHRAE Applications Handbook, p. 13.14

NIH Vivarium Design Policy and Guidelines, pp. D-12, D-15-16

4. Electrical Systems

4.1 Design Criteria

A. Introduction

The electrical system in an animal research facility should be designed to safely provide adequate, reliable, and cost-effective power. In such facilities, the electrical system is as critical as the mechanical and plumbing systems. Redundancy is of primary concern in the system. Electrical systems must accommodate a large, redundant mechanical system with its air handlers, associated pumps, and fans for supply and exhaust systems as well as a system to provide appropriate lighting under both normal and emergency operating situations.

B. Background

Because of the inability of the operator of a vivarium to easily relocate the animal occupants of the facility for any reason, the electrical system must have the ability to provide power on an uninterrupted basis to the building systems serving animal housing areas. Other rooms, because of the nature of hazardous materials present, also have extremely stringent ventilation and room pressure offset requirements that must be maintained at all times. Life safety as well as research integrity preservation issues must be considered in the facility design philosophy.

C. Data

Some of the systems that must remain functional in both normal and abnormal conditions are:

1. Air supply
2. Air exhaust
3. Animal room lighting
4. Animal feeding and watering system
5. Data gathering and building control system
6. Environmental rooms
7. Security system
8. Cage washing and sanitizing equipment (at reduced capacity)

In facilities containing animal operating rooms, applicable regulations covering hospitals may be used as a guideline for those rooms. These would include but not necessarily be limited to special grounding systems, isolation/voltage regulation-type transformers, surgical or high- intensity overhead lighting, and local operating room type distribution grounding panels.

D. Standard

Electrical System Design Criteria	
Code Compliant	National Electric Code (latest edition)
Normal Power	Separate, redundant feeders from the local power distribution company with automatic switch over capability
Emergency Power	All animal life support backed up by emergency generator sized for NI- capacity
Loading	All emergency equipment to be prioritized for restart on emergency power

E. References

Handbook of Facility Planning, Vol. 2: Laboratory Animal Facilities, T. Ruys, ed. 1991. New York: Van Nostrand Reinhold. 422 pp.

Guide for the Care and Use of Laboratory Animals, revised 1996. NIH Pub. No. 85-23. Washington, DC Public Health Service.

Mitchell BSRB BOD

4.2 System Descriptions

4.2.1 Normal Power Service and Distribution

A. Introduction/Background

In an animal facility, the electrical system is as critical as the mechanical and plumbing systems. Redundancy is of primary concern electrically as well as mechanically. Electrical systems in animal research facilities should be designed to provide adequate, reliable, and cost-effective power. Electrical systems must accommodate a large, redundant mechanical system, including air conditioning equipment for supply and a segregated, redundant exhaust system.

B. Standard

1. Primary Power Distribution System Description

a) Primary power for the facility will be obtained from a local public utility usually at 4.16 kV. The primary system will be dual fed, double ended. Transformers necessary to step down the utility distribution voltage to 4.16 kV will be located in a power distribution vault in the building or outdoor pad mounted onsite.

b) Primary 4.16kV switchgear will consist of medium voltage vacuum circuit breakers. The breakers will be electrically operated.

c) Primary power will be distributed to secondary unit substations by way of dedicated feeders.

d) The primary switchgear will provide automatic transfer of all loads to one feeder circuit in the event one of the two feeders fails.

e) The switchgear will be provided with ground fault protection. The switchgear main overcurrent protection device will be coordinated with the utility overcurrent devices.

2. Secondary Power Distribution System Description

a) Power at the standard 480 / 277 volt, 3-phase level will be obtained from 4.16kV step- down transformers. These transformers will be arranged in a double-ended arrangement with normally open bus tie breakers between the secondary switchboards. Transient voltage surge suppression will be provided at the main switchboards.

b) 480 volt, 3-phase power will be distributed to motor control centers (MCC's) to serve concentrated motor loads. These MCC's will contain combination disconnect starter units, 120 volt control transformers and shall be equipped with push-to-test pilot lights.

c) 480 / 277 volt, 3-phase power will be distributed to proper distribution panels to serve 277 volt lighting panels and step-down transformers to obtain 208 / 120 volts.

d) 208 / 120 volts will be distributed from branch circuit panel boards to serve receptacles and equipment. Transient voltage surge suppression will be installed in each branch circuit panel board.

C. References

Handbook of Facility Planning, Vol. 2: Laboratory Animal Facilities, T. Ruys, ed. 1991. New York: Van Nostrand Reinhold. 422 pp.

Guide for the Care and Use of Laboratory Animals, revised 1996. NIH Pub. No. 85-23. Washington, DC Public Health Service.

Mitchell BSRB BOD

4.2.2 Emergency Power Systems and Distribution

A. Introduction/Background

In an animal facility, the electrical system is as critical as the mechanical and plumbing systems. Redundancy is of primary concern electrically as well as mechanically. Electrical systems in animal research facilities should be designed to provide adequate, reliable, and cost-effective power. Electrical systems must accommodate a large, redundant mechanical system, including air conditioning equipment for supply and a segregated, redundant exhaust system.

B. Standard

1. System Description

a) Emergency power will be provided by diesel engine generator sets. The units will generate 4801277 volt, three-phase power, which will be connected to a paralleling switchboard. This switchboard will serve the emergency distribution panels in the building. Automatic transfer switches will be utilized to connect to the emergency source based upon a pre-set priority if the normal source of power fails. Transfer switches will be located near the normal source unit substation. Paralleling switchboard vendors will be pre-approved for the project.

b) A permanently mounted load bank will be provided to allow for the required testing of generators.

c) The quantity of generators will be such that a generator can be taken out of service and the remaining generators can assume the load.

d) 480 volt, three-phase power will serve motors and large equipment loads, such as system pumps, air handling units and exhaust vans.

e) 480/277 volt, three-phase power will serve life safety lighting and step-down transformers to obtain 208/120 volts.

f) 208/120 volts will serve the fire alarm system, selected receptacles and small critical equipment loads.

g) Loads other than life safety types to be served would include but not be limited to freezers, cold rooms, incubators, receptacles in communication, electrical and mechanical rooms, selected receptacles in laboratories and selected MEP equipment as identified by the design team. If the building contains rooms requiring pressure offsets, additional loads will require connection to the emergency system such as ventilation and control systems that will ensure such pressure offsets are maintained at all times.

h) Seventy-two full load running hours of fuel will be provided.

2. Explanation of Operation

a) Failure of the normal source of power will be sensed by devices in each automatic transfer switch. Upon detection of power failure a signal will be sent to the generator switchgear, which will send a start signal to all active generators. The first generator, which achieves proper voltage and frequency, will connect to the emergency switchgear bus. The remaining generator(s) will synchronize with the first generator prior to connecting to the bus. The automatic transfer switches will connect to the emergency bus when the voltage and frequency reach the correct levels.

b) A load sensing system will be provided such that if one generator can carry the emergency load requirement, the remaining generator(s) can be shut down. Conversely, if the switchgear senses the operating generator is becoming overloaded, a signal will be sent to start a second generator.

c) When the normal source returns and after a preset time delay (to establish that the presence of the normal source is not temporary), the transfer switch will connect the load to the normal source. After removal of the load from the engine generator, the unit will continue to run for a preset cool-down time period before stopping.

C. References

Handbook of Facility Planning, Vol. 2: Laboratory Animal Facilities, T. Ruys, ed. 1991. New York: Van Nostrand Reinhold. 422 pp.
Guide for the Care *and Use of Laboratory Animals,* revised 1996. NIH Pub. No. 85-23. Washington, DC Public Health Service.
Mitchell BSRB BOD

4.3 Lighting

A. Introduction

Strict control of light cycles in animal housing rooms is essential. It is standard practice for all animal housing room lights to be automatically controlled. In addition, there should be positive feedback to assure proper functioning of the lights, such as a photocell located in the room. It should not be assumed that by monitoring the status of the relay controlling the lights, the lighting within the room is also monitored. According to a 2004 study, disturbed lighting for socially-housed male mice can cause physiological and behavioral changes indicative of stress, not only leading to much higher levels of corticosterone, but also to shorter agonistic latency within the groups. (Van der Meer)

B. Background

Our typical set up is lights on at 0700 and off at 1900. However, there are applications requiring light/dark cycles that differ from the standard. Therefore, the light control system must be easily manipulated to make necessary changes. The lighting system must provide a means of positive feedback to indicate alarm conditions.

Researchers need to access their animals at all times of the day and night, according to their research requirements. Access during dark hours must be accommodated by the use of an override switch located at the animal room. Ideally, this dark cycle override would be a red lamp which is invisible to most rodents. Override should be for a fixed period of time, typically 15 minutes, to prevent light cycle disruption. Light override period should be adjustable to allow for periods shorter or longer than the typical override period.

Light fixtures must be sealed to prevent the transfer of air and potential contaminates between the room and above ceiling space. Surface mounted fixtures are preferable, as they are more easily sealed. Fixtures with perforations in the ballast housing are totally unacceptable.

C. Standard

Light Levels	
Off / Dark Cycle	0 ft-C
Low / Dark Cycle Override	10-15 ft-C
Medium / Animal Housing Light Cycle	25-35 ft-C
High/Procedure Room Light Cycle, Sanitation of room between popula-	804t-C
Lighting Standard Requirements	
Cycle Controls	Individual room Light/Dark cycles are controlled centrally by the Building Automation System to ensure consistency in diurnal cycles. On/Off times and override durations are easily changed by authorized Animal Facility personnel. The system will allow rooms to be programmed individually.
Monitoring	A photocell connected to the Building Automation System (BAS) is located in each room to monitor the actual lighting condition in the room. Ideally, the photocell records the actual light level in foot-candles. Minimally, the photocell records lights on or off.

Override	A local switch is located at the room to override the lights. Duration of override is programmable by the authorized Animal Facility personnel. During light cycle, the override switch turns the lights off. During the dark cycle, the override switch turns the lights on to the Low level. Ideally, the dark cycle override would be a red lamp(s).
Fixtures	Fixtures are gasketed and weatherproof. Surface mounted fixtures are preferred, since they are easier to seal. Fixtures do not have any perforations that would allow air exchange between the room and the space above the fixture.
Alarming	Conditions outside normal settings must generate an alarm, both within the system and as a critical alarm, via dry contact, to Monitoring Services.

D. References

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Pg 34-35.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D.7.3.1 Lighting Controls.

Handbook of Facilities Planning. Volume 2: Laboratory Animal Facilities. T. Ruys, ed. 1991. New York: Van Nostrand Reinhold. Section 7.6.3 Lighting.

Cosgrove, C., Lehner, N. D. M., Lutz, D., et al. 2003. Vivarium Automation Part 2. Animal Lab News September/October.

Van der Meer, E., P. L. P. Van Loo, and Baurmans, V. 2004. Short-term effects of a disturbed light-dark cycle and environmental enrichment on aggression and stress-related parameters in male mice. Laboratory Animals 38(4):276-383.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

4.4 Wiring Devices

A. Introduction

The electrical wiring devices used in animal vivaria construction follow design parameters of other systems to provide a safe, consistent environment for the animals and human occupants during both normal and emergency operating conditions.

B. Background

The electrical devices provided for a vivarium are generally no different from those in other installations. Consideration is, however, given to a few areas, making the use of the devices more suitable considering the animal inhabitants of the building. Two such considerations are in vermin control and damage from moisture.

C. Data

Light fixtures, timers, switches, outlets, and other devices should be properly sealed to prevent vermin from living there. Wiring devices can become warm during use, and would provide good breeding areas for vermin if allowed access inside the devices. Surface mounted, energy- efficient fluorescent lights are most commonly used in animal facilities. As another precaution, light bulbs or fixtures should be equipped with protective covers to ensure the safety of the animals and personnel.

The electrical devices in some rooms in a vivarium should be capable of operating safely in high-moisture areas, simply because water is used regularly in the areas by operating personnel to maintain cleanliness of the rooms. Moisture-resistant switches and outlets protected by ground-fault interrupter circuitry should be used in areas of high water use. Operating personnel should be consulted during the design stage for recommendations of which rooms should have such devices.

D. Standard

Vivarium Wiring Device Requirements	
Seal all wiring devices	Prevent access by vermin
Seal and waterproof wiring devices and light fixtures	Prevent water damage and air leakage

E. References:

Handbook of Facility Planning, Vol. 2: Laboratory Animal Facilities, T. Ruys, ed. 1991. New York: Van Nostrand Reinhold. 422 pp.

Guide for the Care and use of Laboratory Animals, revised 1996. NIH Pub. No. 85-23. Washington, DC Public Health Service.

Mitchell BSRB BOD

4.5 UPS

A. Introduction

Uninterruptible Power Supply (UPS) systems are used to provide power to electrical devices in the event of failure of the device primary power source. UPS systems are only designed to provide power for a short period of time, sometimes only long enough to allow the equipment to perform an orderly shut down automatically, or to give the equipment operator time to shut the system down in an orderly manual sequence. A UPS system may also provide smooth, uninterrupted power to a device during the interim time between loss of normal power and establishment of emergency power coming from a facility emergency generator. Such transfers sometimes are accompanied by power "spikes" or other anomalies. If such anomalies are considered harmful to a device, then the use of a dedicated UPS system may be called for to minimize the risk of harm in a power failure event.

B. Background

In the context of this design standard, UPS systems are not to be confused with Emergency Power Systems, described elsewhere.

C. Standard

No provision for a large, centralized UPS system will be provided. UPS systems, if required by equipment used by the occupants, should be provided by The University of that equipment.

D. References

Mitchell BSRB BOD

4.6 Lightning Protection

A. Introduction

Studies by the American Geophysical Union confirm that conventional lightning protection systems are highly effective in reducing lightning-caused fires and damage to buildings and structures. Specifying compliance with UL or NFPA standards is key to safe and effective lightning system performance.

B. Background

UT HEALTH facilities Basis of Design (BOD) documents indicate past practice of specifying lightning protection systems meeting Underwriters Laboratories Master Label Certification requirements.

C. Data

Lightning protection systems that have received the UL Master Label Certificate comply with national standards and include all of the following specified components:

1. Network of rooftop air terminals
2. Network of grounding terminations
3. Network of conductors interconnecting the air terminals and grounds
4. Interconnections with metallic bodies
5. Lightning protection surge arrestor devices on all incoming power and communication lines.

D. Standard

Vivarium facilities will be protected with a lightning protection system meeting UL Master Label Certificate requirements.

E. References

Mitchell BSRB BOD
Underwriters Laboratories, Inc., Copyright 2006, Online Policies.

5. Information Technology Systems

5.1 IT Cabling

A. Introduction

Data, voice, and visual communication (IT Systems) capability is vitally important in an animal vivarium facility. The foundation of the IT systems installed in any facility is that of the various cabling materials used in those systems. Quality of the installed IT system as well as its capability to be successfully upgraded in the future are both dependent upon the selection of cabling materials.

B. Background

The communications cabling will be designed following the tenets of the UT UT HEALTH Premise Distribution System Standards document in accordance with AVAYA Communication Certified Systimax Structured Cabling System parameters to provide a vendor-neutral network transport.

The communications cabling will be specified as a competitively bid structured cabling system equivalent to the AVAYA Systimax Structured Cabling System.

The Information Technology (IT) structured cabling system will be designed and sized to accommodate the cabling needs of all low voltage systems not identified with proprietary cabling requirements. The IT structured cabling system will be defined as, and comprised of, raceways, conduits, sleeves, cable tray and runway, copper cabling and fiber optic cabling serving low voltage systems. This system will function to provide interconnectivity for low voltage systems that will meet the needs of current systems and those requirements in the future.

C. Data

1. Applicable Codes, Guidelines, and Standards
    - a) NFPA 70-National Electrical Code (NEC)
    - b) BICS I Telecommunications Distribution Methods 11th Edition
    - c) ANSITTIA/EIA-568-A Commercial Building Telecommunications Cabling Standards
    - d) ANSI/TIA/EIA-569-A Commercial Building Standards for Telecommunications Pathways and Spaces
    - e) ANSI/TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
    - f) ANSITTIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
    - g) TIA/E IA 568-A-5 568-A Addendum 5 - Category 6a
    - h) TINEIA TSB-67 Transmissions Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems
    - i) TIA/E IA TSB-72 Centralized Optical Fiber Cabling Guidelines
    - j) AVAYA Communication Certified SYSTIMA>Structured Cabling system Technical Specifications

D. Standard

1. Load Calculation Criteria

a) Device locations will be established during the Information Technology (IT) user meetings and are to be indicated on the 100% construction documents for review by UT HEALTH.

b) The Standard Information Outlet (S10) device for office and support spaces is configured typically in a "Gad" faceplate with two (2) copper data jacks and two (2) copper voice jacks.

c) Each SIO for Vivarium Laboratory and Double Module Laboratory spaces will be configured into a "Duplex" faceplate with one (1) copper data jack and one (1) copper voice jack. Provisions have been included in the raceway sizing criteria for one (1) pair of multimode fiber optic cable. SIO details will be included on drawings.

d) All SIO locations will be confirmed with UT HEALTH Telecom & Network Services for final voice and data jack configurations. Each SIO type to be indicated on the plan set and detailed.

2. Equipment Sizing Criteria

a) **Preliminary Backbone Sizing**

1. Voice Riser Cabling: Pair count is based on one and one half (1.5) riser pairs for each voice station jack served by the Intermediate Distribution Frame (IDF) Room. The riser cables will be sized to contain a minimum of 20% unallocated pairs for future use.

2. Data Riser Cabling: Fiber count has been preliminarily set at twenty-four (24) multimode and six (6) strands off singlemode fibers and twelve (24) single-mode fibers routed to each IDF.

3. Data Interconnecting Cabling: Fiber count had been preliminarily set at six (6) strands of multimode fibers routed across each floor between IDF's.

b) Pathway capacities will be utilized to the maximum of 40% to 50% fill and sized to allow for 50% future growth. At least one (1) spare riser sleeve or conduit will be provided between floors.

3. IT Equipment Rooms

a) **Building Entrance Facility** (BEF)

1. The building BEF will be located on plan level 1 within the BEF/Main Distribution Frame (MDF) room and will be the point where the building connects to the campus networks. All fiber optic and copper cabling coming into the building will terminate in this room. This room will contain the building demarcation point, lightning protection, and cable transition. Connections to the MDF will bring services to the Distribution Switch.

2. Data network services will enter the building through optical fiber cabling from the existing IDF Room.

3. Voice services will be provided in the building either through copper cabling provided by the local

exchange carrier or by a local PBX

4. Space should be designed into the BEF/MDF room to accommodate an owner provided PB)system or LEC system equipment.

b) **Main Distribution Frame Room** (MDF)

1. The building MDF will be co-located with the BEF within the BEF/MDF room and will be the point from which the building services originate. The Distribution network switch will be located in the MDF, distributing network services to the entire building via the Fiber data backbone.

2. The MDF will also provide the cross-connect point to distribute telephone service from the telephone switch equipment to each IDF. The telephone switch equipment cabinets will be rack mounted. From the backplane of the telephone switch equipment cabinets, telephone services will be distributed to a rack mounted termination point. From the telephone switch equipment blocks, cross-connects will route telephone service to intra-building backbone cables. All communications cabling within this room will be secured using a Velcro type "Tie-Wrap" instead of the plastic type "Tie-Wrap".

c) **Intermediate Distribution Frame Room** (IDF)

1. IDF's will be located in an area convenient to the floor it will serve to provide a lockable protected & climate controlled environment for terminating all backbone and station cabling on that floor. Workgroup Access Layer Switches will also be housed in the IDF's, distributing network services to the entire floor via the data station cabling.

2. Each network device will be configured with redundant power supplies and will require two (2) 120 volt, 20 amp branch circuits. All circuits for active electronics will be fed from the standby power system with rack mounted uninterruptible power system (UPS) units provided by The University for each equipment rack.

3. All 120 volt circuits for active electronics will be specified as dedicated, with separate neutral and equipment grounding conductors routed back to the nearest stand-by power panel without mechanical equipment loads. One (1) convenience outlet fed from the normal power system will be provided in each IDF.

4. Equipment panels for security, fire alarm, building automation systems, etc. will be centrally located within the interstitial spaces and co-located on the wall space(s) designated by Network Service within the IDF's on those floors without interstitial spaces.

4. Electrical Requirements

a) Each network device will be configured with redundant power supplies and will require two (2) 120 volt, 20 amp branch circuits. A minimum of one (1) 120 volt, 30 amp branch circuit will be provided. All circuits for active electronics will be fed from the standby power system with rack mounted uninterruptible power units (UPS) provided for each equipment rack. Owner to verify all power requirements for equipment provided.

b) All 120 volt circuits for active electronics will be specified as dedicated, with separate neutral and equipment grounding conductors routed back to the nearest stand-by power panel without mechanical equipment loads. Convenience outlets fed from the normal power system will be provided 25' on center on the perimeter wall of the IDF room.

c) Fluorescent lighting, fed from the standby power system will be installed within the HUB room.

5. Equipment and Material

a) **Cabling System Pathways**

1. Multiple 4" conduits and cable tray shall connect the MDF to the stacked IDF's, and 4" sleeves shall be provided between IDF's on each floor.

2. Each IDF room shall be provided with cable runway over the equipment racks. The cable runway will be bonded and properly grounded in compliance with the NEC to the cable tray system.

3. Horizontal distribution will start with multiple 4" conduit sleeves from the IDF cable runway to a cable tray. The cable tray will be run through the public corridors of the floor plate on floors without an interstitial space and routed throughout the interstitial spaces to serve the station conduits for the spaces on the interstitial level and the floor below. Cable tray will be an aluminum, ladder-type.

4. Station conduits will be run from the cable tray to the outlet location. Conduits will be 1" minimum, with

end bushings and metallic grounding clamps for bonding the conduit to the cable tray.

b) Voice Backbone Cabling

1. Intra-building voice backbone cabling will be high pair count copper cables. Both ends will be terminated on rack-mounted X LBET (extra large building entrance terminal frames) 110 style connection blocks. The MDF will connect to the IDF with an intra-building voice backbone cable. These cables will create the cross-connect fields to distribute telephone services throughout the building.

c) Voice Station Cabling

1. Each voice jack in the building will be connected to the IDF on that floor by a 4- pair UTP, category 6a cable. All four pairs of the cable will terminate at the outlet location and in the IDF using the T568B wiring scheme. Category 6a rated 8P8C type jacks will be used at the outlet locations, and category 6a rated, rack mounted type termination points will be used in the IDF's. Plenum cabling will be specified in all areas designed with plenum return air systems.

d) Data Backbone Cabling

1. Data backbone cabling will be multi-mode and single-mode optical fiber cable, and all IDF's will be a home run connection to the MDF. Data backbone cabling will be terminated in rack mounted, rack installed, Light Shelf Terminations (LST's) using AVAYA SC type fiber connectors.

e) Data Station Cabling

1. Each data jack in the building will be connected to the IDF on that floor by a 4- pair UTP, category 6a cable. All four pairs of the cable will terminate at the outlet location and in the IDF using the T568B wiring scheme. Category 6a rated 8P8C type jacks will be used at the outlet locations, and category 6a rated, rack mounted style termination point will be used in the IDF's. Plenum cabling is specified in all areas designed with plenum return air systems

f) Data Patch Cables

1. Owner provided, data patch cables will be provided to match the rack mounted terminations. These cables will complete the category 6a rated channel.
2. Pre-terminated multi-mode optical fiber patch cables will be provided to match the jack-fields, outlet, and cable equipment.

g) Inner duct

1. Backbone fiber optic cabling will be installed in flexible, corrugated, nonmetallic inner duct. This inner duct will protect the cables and segregate conduits and conduit sleeves. Inner duct is specified as UL listed and comply with NFPA 70 for all installations.

h) Equipment Racks

1. Fiber optic data patch panels will be rack mounted in each **IDF** and rack mounted on ?LBET frames within the BEF/MDF room. Active electronic equipment will be installed in floor mounted equipment racks. Vertical and horizontal wire management will be provided.

I) Cable Runway

1. Cable runway will be used in the BEF/MDF room and IDF's. The runway provides flexibility in the tight confines of the communications rooms and helps to insure an orderly cabling installation. It is also used to help brace the equipment racks.

j) Communications Ground

1. A communications grounding system will be installed to connect all of the building IDF's with the HUB room. The grounding system will be derived from the building electrical service to insure there is no difference in potential between it and the building communications systems.

k) Wireless Access Points

1. Category 6a cabling shall be pulled into designated locations specified by Network Services to accommodate Wireless Access Points.
2. Wireless Access Points will be installed by owner.

6. Distribution

a) Cable distribution within the building will be accomplished using the IT structured cabling system in conduits, conduit sleeves, cable trays and cable runways.

b) Line voltage, BAS, Security, CCTV and speaker cabling will NOT be routed in the IT structured cabling raceway. All "other" cabling will be routed in the pathway designated for the IT structured cabling system to insure coordination of all system cabling paths.

c) D-rings and cable runways will be used only in the BEF/MDF room and IDF's.

E. References

Mitchell BSRB Basis of Design document

NFPA 70 — National Electrical Code (NEC)

BICSI Telecommunications Distribution Methods 11th Edition

5.2 Security

A. Introduction

The objective of security is to ensure the safety of the animals, staff, equipment, and data. Conventional entrances, such as man-doors and dock bay doors, must be equipped to control access to the animal facility. Proximity card readers and number pads are used within the vivarium. Security must be designed so that approved users may move about the facility easily with minimal hindrance while unapproved individuals are denied access.

In addition to conventional entrances, security at other potential entry points must be considered. Windows, air intakes, and other central utility entrances and exits must be protected from intruders.

B. Background

The levels of security required for the animal facility are:

1. External Perimeter: Entrances leading into the vivarium from non-vivarium spaces.
2. Internal Perimeter: Entrances from vivarium administrative space into animal housing and use space.
3. Functional Area Perimeter: Entrances into specific areas within the facility, e.g., imaging suite, cryo-preservation laboratory, irradiator rooms, animal receiving and quarantine, receiving dock, etc.
4. Animal Housing Suite: Entrance into discrete group of animal housing and procedure rooms
5. Animal Housing/Procedure Room: Entrance into a specific housing/procedure room

C. Standard

Security Requirements	
Item	**Direction**
Perimeters and Suites	UTPD card readers, digital recording security cameras trained on all external and internal perimeter entrances and throughout animal housing area corridors
Housing/Procedure Rooms	Individual room control requiring a PIN to enter, programmable through the electronic facility management system (e.g. Edstrom Watch-Dog)

Non conventional entry points	Intrusion alarms, mesh covers, or other appropriate means of preventing entry
Duress Alarms	One in each locker room, central administrative area, each animal housing suite, strategic locations in housing area corridors
Card Reader and PIN access systems	Must be programmable and able to allow multiple levels of security clear-

D. References

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Standard B.4.2.

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. pg 43-44.

5.3 Closed Circuit Television (CCTV) Surveillance

A. Introduction

Security in the animal facility is of paramount importance. Proximity card readers, locks and keys, and PIN key pads afford a level of perimeter and internal access control. However, it is important to monitor the movements of people and equipment once inside the facility via strategically located surveillance cameras. Closed circuit TV (CCTV) surveillance cameras are used to identify events such as individuals entering the facility inappropriately (e.g., "tailgating," insufficient or incorrect protective clothing, etc.), individuals behaving in an inappropriate manner (e.g., incorrect animal transport, horse playing, etc.), and unauthorized use or removal of property.

B. Background

UTPD's Crime Prevention and Technical Services groups should be involved from the beginning of a project to allow for thorough assessment of security needs. Ideally, there would be virtually total surveillance coverage of all main corridors. Minimally, all perimeter entrances and internal entrances, like locker rooms, must be visually monitored and recorded by UTPD. Many requests to review surveillance camera recording are in response to inappropriate behavior, rather than true security issues, so it is desirable for DVMS to also be able to monitor animal facility CCTVs. Since the videos are used to positively identify individuals and what they are doing, it is very important that the camera produce a clear image that can be zoomed and remain clear when zoomed. Communication between camera and monitoring devices must be secured against tampering or other damage.

C. Standard

CCTV Requirements	
Item	**Direction**
Cameras	Must provide clear view of the area of coverage, even when zoomed on the monitor. Should be able to zoom and pan.

Camera locations	- at all perimeter entrances to the facility - at all locker room or other entrances into the animal housing area - all elevator lobbies and elevators - all main corridors
Recording devices	- multi-camera capabilities - programmable alarming - network client software license for DVMS Project Manager
Cable security	
Monitoring	All animal facility CCTVs are monitored by UTPD. Ideally, all vivarium CCTVs are also monitored in the DVMS Project Management (PM) office through the use of an Intellex or comparable recording device. Minimally, all perimeter and internal entrance CCTVs are monitored in DVMS the PM's office.

D. References

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities.

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals.

Project Manual, South Campus Vivarium, GMP-2 100% Construction Document Submittal

5.4 Fire Alarm

A. Introduction

Life safety in the animal facility is of paramount importance. However, this must be balanced by the needs of the animals. An acceptable compromise must be reached that accomplishes the goal of adequately notifying human occupants of a danger while causing the least disruption to the animal colony.

B. Background

Many times, an alarm is triggered in the absence of a real danger to life safety. It is desirable that these false alarms cause no disruption to the animal colony. Audible alarms must be able to emit a chime, rather than a horn, within the animal housing suites and main hallways. Only visual alarms are allowed within animal housing rooms and must have red lenses.

A variance from the Texas Department of Licensing and Regulation (TDLR) was required to allow visual only fire alarms within animal rooms. (See Variance Application for details in the Appendix.)

C. Standard

Fire Alarm Requirements	
Item	**Direction**
Animal room visual alarms	Red lens, weatherproof gasket, sealed

D. References

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Standard B.4.2.

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. pg 43-44.

Project Manual, South Campus Vivarium, GMP-2 100% Construction Document Submittal

5.5 Wireless Data

A. Introduction

The modern animal housing facility is equipped with many different computer-based systems including, but not limited to, building automation, vivarium management, breeding colony management, and communications. Access to these systems is often required away from a hard-wired wall jack.

The term "wireless network" can be used to describe any type of network that is wireless, but the term is most commonly used to describe a telecommunications network that does not use wires to establish interconnections between nodes. Wireless computer networks are examples of these types of telecommunications networks.

Wireless Fidelity ("Wi-Fi") is a commonly used wireless computer network that uses radio waves. Radio technologies called IEEE 802.11 are transmitted from access points. Wireless devices use receivers to detect the signal. A Wi-Fi network can be used to connect computers to each other, to other wireless devices & networks, or to the Internet.

5.6 Communication

A. Introduction

Communication within and between animal facilities is an important aspect of departmental operations. Staff members must be able to communicate quickly and accurately. Most of the animal care staff do not carry institutional pagers, so there must be a mechanism for communication to and from these individuals. Overhead paging and hallway telephones serve this purpose. Hallway telephones also allow for returning pages, for those individuals with pagers or Blackberry devices. The wireless system allows uninterrupted computer communication throughout the facility. (e.g., for animal care staff moving from room to room using ViewPort or other data management system to enter data.)

B. Background

A number of communication devices are used in the animal facility, including but not limited to, phones, pagers, Blackberry devices, wireless computers, and ViewPort. It is imperative that these devices be configured with wiring or signaling devices such that they have uninterrupted service throughout the facility. It is unacceptable to have "dead spots" where a signal may be lost. On the other hand, the increasing use of radio transmitters in personal communication devices is resulting in more incidences of unintentional interferences with other electronic equipment. The wireless network interfaces, cellular phones, personal digital assistants, and two-way radios contain transmitters that are powerful enough to cause interferences in many electronic systems such as telephones, personal computers, electronic control systems, etc. Some research centers have experienced interferences in their freezer electronic control systems, electronic actuators controlling air dampers, and transducers controlling branch line pressure when a handheld two-way radio is operated nearby.

C. Coordination

Contact UT HEALTH Information Technology for specifications

5.7 Database Information Management

A. Introduction

A vast amount of information is generated in the animal facility on a daily basis. Environmental conditions must be recorded on a regular basis through the building automation system (BAS) and/or other environmental monitoring systems. As the animal care staff performs routine procedures, completion of the procedures must be documented. Any other activity that has a relationship to animal health and wellbeing should also be documented. Electronic management of data is preferred to paper copies, since electronic records may be sorted, graphed, searched, and archived.

B. Background

Commercially available database systems are available for collection, documentation, and manipulation of vivarium information. The system should allow for easy data entry, searchable records, and reporting capabilities. Data security is of paramount importance and must be protected through the use of passwords, restricted access based on job function, and other appropriate controls.

C. Standard

Database Information Management Requirements	
Item	**Direction**
Data security	System must follow policies and guidelines described in the M. D. Anderson Information Security's *Security Policy and Operations* Manual and Information Security institutional policy.
Multiple Users	System must allow multiple users at any given time
System to system interface	Ideally, the system will utilize an open protocol to allow communication between database systems
User interface	Must be user-friendly and intuitive. Must be customizable and tailored to the specific facility.
Compliance	Comply with 21 CFR Part 11, Electronic Records; Electronic Signatures

D. References

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities.

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals.

Larkins, D. Data Management in the Rodent Animal Research Facility. *Animal Lab News.* May/June 2005. http://www.animallab.com/articles.asp?pid*04

Title 21 Code of Federal Regulations (21 CFR Part 11) Electronic Records; Electronic Signatures. *http://www.fda.gov/ora/complianceref/part11/*

6.0 Architectural Materials & Finishes

6.1 Functional Areas

A. Introduction & Background

An animal research facility is a specially designed building type. The design and size of the facility depends on the scope of the animal research program, the species to be used, the physical location in relation to the other research areas, and the geographic location. The vivarium must maintain closely controlled environmental conditions and must be designed to protect the research animals from exposure to conditions, pathogens, and agents that could alter research results. Functional areas must be defined in order to develop a well-planned and efficient facility.

B. Data 1. Functional areas of an animal facility may include:

a) Animal Housing Rooms (AHRs) - AHRs can be organized as individual rooms accessed from a corridor system or multiple rooms could be organized into self-contained suites.

b) Procedure Rooms — procedure rooms should be located within or close to the AHRs. Maximum flexibility is maintained by designing procedure rooms that can be used interchangeably as animal housing rooms, i.e., procedure rooms should be identical to animal housing rooms. Procedure room furniture and fixtures should be modular and mobile, to allow for total room conversion between procedure and housing.

c) Barrier Facilities — This area is designed to maintain bio-security for specific pathogen free animals. The rooms operate under positive pressure to keep contaminants out. As in containment facilities, control and monitoring systems and equipment are utilized in barrier facilities to maintain the required pressures and flows.

d) Barrier Elements - Airlocks, locker rooms, pass-through autoclaves, etc., provide the primary barrier and access control that separates the controlled animal care environment from external influences.

e) Cagewash — The cagewash complex is the central area for decontamination, cleaning, and sanitizing of animal care equipment and supplies. These areas are dominated by equipment-generated heat, moisture, noise, and vibration. The major equipment items include cage & rack washers, tunnel washers, autoclaves, bedding dispensers and dump stations, and bottle filling stations.

f) Cage Storage — Storage space is required for items that are used in daily operations, such as staged or processed cages, bottles, racks, carts, etc.

g) Feed, bedding, & equipment storage — This storage area should be located to facilitate operational flow. Appropriate separate storage areas for these and other items should be included.

h) Quarantine — A specialized containment area is needed to house incoming animals that could be a source of infection. This area should be physically separate from the central housing area to minimize the potential for contamination.

i) Dedicated Receiving Dock - A dock specific to animal functions is generally required. An elevator dedicated to animal usage should be located near the dock.

j) Necropsy - This area is used for post mortem procedures on euthanatized or otherwise deceased animals. This function should either be located physically separate from "clean" areas or separated by a pressurized pass-through air lock.

k) Containment Facilities - These areas are designed for working with potentially infectious biological agents. They operate under negative pressure to prevent the escape of air to the general environment. Wastes and effluents are separately contained and decontaminated.

l) Veterinary Care — This area may include laboratory, surgery, and clinical care functions.

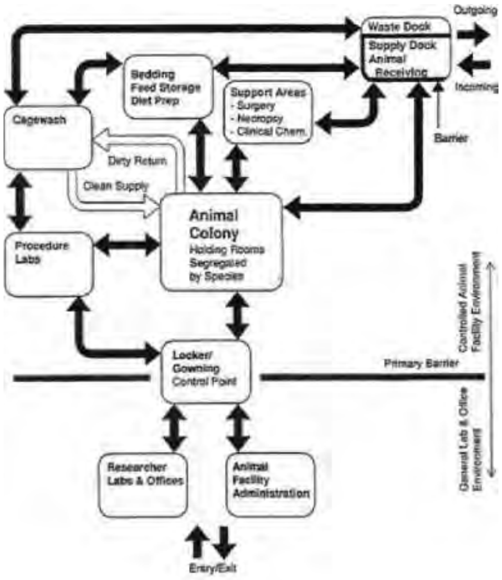
m) Office Space — Office area is required inside the vivarium for veterinary and animal care staff.

n) Staff Support Areas teak area, cafeteria as, workstation, lockers, and rest-room facilities. All are intended to support veterinary and research staff during their work shift.

o) Mechanical/Electrical Equipment Spaces — This area includes mechanical equipment rooms, and electrical and telecommunications closets. It is desirable to locate the spaces and devices in a manner that allows the separation of maintenance functions from animal care functions.

p) Corridors - These should be wide enough to accommodate animal rack, cart, and material traffic flow, not just egress requirements. Corridors should have a clear width of 7'-0" to 8'-0". Corridors should have impervious finishes so that they are easy to clean and maintain. Protective components such as bumper and corner guards, bull nose blocks and cove bases are frequently employed to protect walls and doors from heavy, abusive traffic.

The general organization of a vivarium is illustrated below:



Animal Facility
Diagramatic Model Showing
Basic Flows and Spatial Relationships

2. Important Attributes

a) Internal circulation systems need some form of control over clean vs. dirty (or supply vs. return) traffic.

b) The cagewash complex is divided by walls into type-of-use areas, including decontamination, soiled equipment processing, clean equipment processing, autoclave equipment preparation, and autoclave sterile staging.

c) Areas of potential contamination, such as necropsy and quarantine, should be located outside the central housing area.

d) The animal receiving areas should be subdivided to distinguish between incoming animals and receiving, and outgoing waste.

C. References

Guide for the Care and *Use of Laboratory Animals* 7th ed.]ed, ed. I.o.L A.R. (U.S.). 1996, Washington, D.C.: National Academy Press.

Stark, S., J. Petitto, and S. Darr, *Animal Research Facility,* W.B.D. Guide, Editor. 2006, National Institute of Building Sciences: Washington D.C. http://www.wbdg.org/design/animalresearch. php

6.2 Corridors

A. Introduction

Animal facilities should be constructed to be practical, functional, and efficient. Corridors within animal facilities must be able to accommodate the passage of large equipment, bulk materials and supplies, animal transport crates, and research equipment and personnel. The use of single or dual corridor systems is a basic decision that must be made early in facility design.

B. Background

The decision regarding single or dual corridor systems should be based on the following factors: available space, need for contamination control, species to be housed, and cost constraints. Corridors should be wide enough to facilitate the movement of personnel and equipment. Corridors 8 feet wide can accommodate the needs of most facilities. Floor-wall junctions should be designed to facilitate cleaning. In corridors leading to dog and swine housing facilities, cage-washing facilities, and other high-noise areas, double-door entry or other noise traps should be considered. Wherever possible, water lines, drainpipes, electric-service connections, and other utilities should be accessible through access panels or chases in corridors outside the animal rooms. Fire alarms, fire extinguishers, and telephones should be recessed or installed high enough to prevent damage from the movement of large equipment. A map of the corridor system should be provided in main hallways to facilitate wayfinding.

C. Data

Clean-dirty dual corridors systems should be used whenever possible to promote contamination control. Main facility corridors should be 8 feet wide. Junctions between floors, wall, and ceilings should be sealed. Bumper rails or guards and corner guards should be used to protect walls from damage.

D. Standard

Table listing standard
Corridor system Dual; clean-dirty traffic flow
Minimum width I 8 ft

E. References

Volume 2: Laboratory Animal Facilities, (Van Nostrand Reinhold, New York, 1991).

Guide for the Care *and Use of Laboratory Animals* (National Academy Press, Washington, D.C., 1996).

Vivarium Design Policy and Guidelines. (ed. Health, N.I.0.) (NIH Office of Research Facilities, 2006).

6.3 Animal Room Doors

A. Introduction & Background

Doors are installed in animal facilities in corridors and animal rooms. Corridor doors are required to separate functional areas, provide noise control, and enhance facility security. Doors in animal rooms provide many functions, including providing enclosure for the animals, maintaining air balance, providing noise control, and enhancing facility security.

B. Standard

1. Corridor doors should be wide enough to accommodate the movement of equipment and animals. Double-door (vestibule) entries should be considered in corridors that separate high-noise areas. Corridor doors and doors in other high traffic areas are subject to the most extreme abuse in the vivarium. Push button actuators should be provided to discourage people from forcing the doors open with a rack, cart or other piece of equipment. In addition, these doors may require a piano style hinge in order to ensure long term durability. Doors separating elevator lobbies and doors with hold opens should be pocketed or shielded to protect the edge of the door from impacts. The hardware should be carefully chosen to avoid being clipped off by a rack, cart or other piece of equipment.

2. Animal room doors should be large enough to accommodate the movement of cages and equipment. Doors should have seamless construction with smooth, flush surfaces, without visible joints or seams on exposed faces or edges. Animal room doors should be painted hollow metal or FRP, 4'-0" wide by 7'-10" tall (minimum) and should be equipped with recessed or shielded handles, threshold sweeps, and kickplates. All frames should be grout- filled, welded hollow metal with a painted finish. Procedure room doors should be sound retarding painted steel doors with acoustical seals, engineered for attenuation rating of

45 STC minimum.

3. Normally, animal room doors should open inward and be self-closing. If code requires outward opening, the door can be recessed into the corridor wall. Animal housing and procedure room doors should have a view window with shutter. The view window can be coated with a red film similar to that found in a photo darkroom. The red filter will allow animal care staff to check the room without disturbing the animals' day/night cycle. The spectral energy/light range in which mice are sensitive is approximately 325nm to 625nm, so the red film should be chosen based on its ability to screen within that range.

4. Sliding automatic breakaway aluminum entrance doors should be installed at cage wash and clean cage storage.

5. Hardware protection (bumpers) should be installed for all locksets at holding and procedure rooms.

C. References

Guide for the care and *use of laboratory animals* 7th ed.] ed, ed. I.o.L.A.R. (U.S.). 1996, Washington, D.C.: National Academy Press.

CUH2A, I., *7.0 UT HEALTH Architectural Materials & Finishes.* 2006.

6.4 Exterior Windows

A. Introduction

In general, exterior windows are not recommended for animal research facilities and are inappropriate for areas within animal facilities where their presence interferes with the ability to control room temperature (due to heat loss) or photoperiod. Windows can be acceptable in rooms for some species, such as nonhuman primates, dogs, and other large mammals and might be considered as part of the environmental enrichment program for these species. Direct sunlight may even be required in some species of neo-tropical primates in order to obtain necessary vitamin D.

B. Background

The traditional use of windows in building design was to provide light, view, and fresh air for building occupants. This need has diminished over the past few decades as buildings have become more sealed, mechanically ventilated, and electrically lit. There is a growing recognition that the presence of windows makes an important contribution to the occupant's job satisfaction, health, and productivity.

Despite these advantages for the human occupants, windows are not generally recommended for rodent facilities because they:

1. Allow fluctuations of photoperiod and light intensity within the housing room during daylight hours;

2. Interfere with room temperature control due to solar heating; and 3. Reduce

building security.

Since small animals such as rodents need strictly controlled light and dark cycles to maintain animal health and breeding, exterior windows are not normally provided in small animal housing rooms.

C. Standard

Exterior Windows	
Rodent housing room	None
Rodent procedure room	None
Support spaces	Variable based on function and presence of animals

D. References

Hessler JR, Leary SL. Design and Management of Animal Facilities In: Fox JG, Anderson LC, Loew FM, et al., eds. *Laboratory Animal Medicine.* 2nd edition ed. New York: Academic Press, 2002.

Guide for the care and use of laboratory animals *National Research Council.* Washington, D.C.: National Academy Press, 1996.

Windows for High Performance Commercial Buildings. *Center for Sustainable Building Research.* Minneapolis: College of Design, University of Minnesota, 2004.

Clough G. The Animal House: Design, Equipment and Environmental Control In: Poole T, ed. *The UFAW Handbook on the Care and Management of Laboratory Animals.* 7 ed. London: Blackwell Science Ltd, 1999.

6.5 Floors

A. Introduction

Floors should be moisture-resistant, nonabsorbent, impact-resistant, and relatively smooth, although textured surfaces might be required in some high-moisture areas and for some species (such as farm animals). Floors should be resistant to the action of urine and other biologic materials and to the adverse effects of hot water and cleaning agents. They should be capable of supporting racks, equipment, and stored items without becoming gouged, cracked, or pitted. Depending on their use, floors should be monolithic or have a minimal number of joints. If sills are installed at the entrance to a room, they should be designed to allow for convenient passage of equipment.(1991; (U.S.) 1996) Flooring material should be carried up the walls a minimum of 150 mm (6 inches) to provide an integral covered base for ease of cleaning. (Facilities 2006)

1. Durable and capable of supporting heavy equipment & caging systems
2. Nonabsorbent and easily sanitizable
3. Smooth but with non-slip surfaces
4. Able to be carried up the wall for at least 150mm

B. Background

Some materials that have proved satisfactory are epoxy aggregates, hard-surface sealed concrete, and special hardened rubber-base aggregates. Correct installation is essential to ensure long-term stability of the surface. Resinous epoxy flooring is recommended for all floors within animal facilities that are subject to abuse, frequent cleaning, and continuous movement of cages and equipment. Areas that are hosed down shall be surfaced with resinous flooring materials.

Some areas within the animal facility may not require the same amount of cleaning and disinfecting as the areas in which cages and animals are held or transported. These areas are program driven and may consider the use of a monolithic sheet vinyl flooring material. (Facilities 2006)

Polymer flooring that incorporates antimicrobial agents should be considered for use in areas where the control of microbial contamination is desirable, such as surgical suites, necropsy areas, or barrier facilities.

C. Standard

Vivarium Floors	
Animal holding and procedure rooms	Resinous epoxy
Necropsy rooms	Polymer/antimicrobial
Corridors	Resinous epoxy
Cage wash and sterilization areas	Resinous epoxy

Loading docks	Hard surface sealed concrete
Support areas	Monolithic sheet vinyl

Offices Monolithic sheet vinyl

D. References

(1991). Volume 2: Laboratory Animal Facilities. New York, Van Nostrand Reinhold. (U.S.), I. o.

L. A. R. (1996).

Guide for the care and use of laboratory animals Washington, D.C., National Academy Press. Facilities,

N. 0. o. R. (2006). Vivarium Design Policy and Guidelines.

6.6 Drainage

A. Introduction

Adequate drainage is essential in animal facilities. These facilities produce large volumes of waste water during equipment sanitation and animal husbandry tasks. Drainage for either sinks and/or floor drains may be required in support areas, animal procedure rooms, and holding rooms. Floor drains are required in cage wash areas, many equipment processing areas (for autoclaves, etc.), large animal or aquatic animal holding rooms, and janitorial rooms. Many rodent holding rooms and clean support areas can be effectively sanitized by vacuuming and mopping rather than by wet wash down; in these areas, floor drains are not required or desired. The main advantage of including floor drains in these areas is to gain flexibility. Disadvantages include: installation costs, higher rate of insect infestation, contamination resulting from sewage backups, rack instability due to sloped flooring, escape of sewer gas from underutilized drains, and reduction of floor space due to drain troughs. Any unused drain in an animal housing or procedure room must be plugged to create a seal against sewer gas escape, vermin traffic, and other permeating issues so that it may be readily removed if the drain becomes needed in the room.

B. Background

Floors should be sloped at least 1.5 cm per M (3/16 in/ft) to floor drains to ensure rapid removal of water and drying of surfaces. Variation in the substrate (floor flatness) should not exceed 118th in/10 ft. Drains should be located at the lowest point of the floor or drain trough. The bottom of troughs should be sloped a minimum of 2 cm per m (1/4 in/ft). Floor drains should always be sealed effectively by continuously containing fluids or other means. Automatic trap priming should be considered as a method to ensure that traps remain continuously filled. Drain pipes should be at least 4 inches (10.2 cm) in diameter; larger pipes are recommended in some areas, such as large animal runs and farm-animal facilities. A run-flush drain or heavy-duty disposal unit is recommended for disposal of solid waste.

C. Standard

Drainage Standard Requirements	
Sloped floor required for floor drains	Minimum slope =1 .5cm/M
Sloped trough required for drain	Minimum slope .0cm/M
Floor substrate variation	<1/8 th in/10 ft
Minimum drain diameter	4 in
Trap priming	Automatic
Disposal unit	Preferred for solid waste

D. References

Hessler JR, Hoglund U. *Laboratory Animal Facilities and Equipment for Conventional, Barrier, and Containment Housing Systems.* 2nd ed. Washington, D.C.: CRC Press, 2003.

Guide for the care and use of laboratory animals *National Research Council.* Washington, D.C.: National Academy Press, 1996.

Falls JJ, Ruys T. Laboratory Animal Facilities Design Principles In: Ruys T, ed. *Handbook of Facilities Planning.* **1st** ed. New York: Van Nostrand Reinhold, 1991;216-261.

6.7 Walls

A. Introduction

Walls should be smooth, moisture-resistant, nonabsorbent, and resistant to damage from impact. They should be free of cracks, of unsealed utility penetrations, and of imperfect junctions with doors, ceilings, floors, and corners. Surface materials should be capable of withstanding cleaning with detergents and disinfectants and the impact of water under high pressure. The use of curbs, guardrails or bumpers, and corner guards is required to protect walls and corners from damage. All joints between walls and appurtences such as bumpers or guardrails must be sealed with an owner approved caulk or sealant. Walls must provide sound isolation. Other requirements include:

1. Durable and capable of withstanding moderate impact;
2. Non-absorbent, free of cracks & crevices, and easily sanitizable; and 3. All penetrations must be sealed.

B. Background

Concrete masonry units (CM U) are effective for walls, but the block must be sealed to prevent moisture absorption and the joints must be tooled to prevent collection of dirt. Ceramic tile and glazed block are not recommended because of the number of exposed joints. Cement fiber wallboard may be a viable alternative building material to replace CMU. Gypsum wallboard can be considered for certain applications in low moisture, low traffic areas. Cement fiber or gypsum wallboard surface must be properly prepared and coated with approved primer and topcoat to reduce the potential for moisture intrusion.

C. Standard

Vivarium Wall Requirements	
Animal holding & procedure rooms	Cement fiber wallboard or CMU
Necropsy rooms	Cement fiber wallboard or CMU
Corridors	Cement fiber wallboard or CMU
Cage wash & sterilization areas	CMU
Loading docks	CMU
Support areas	Cement fiber wallboard or CMU
Offices	Gypsum wallboard

D. References

Guide for the Care and Use of Laboratory Animals 7th ed. Washington, D.C.: National Academy Press, 1996.

Vivarium Design Policy and Guidelines In: Health NIo, ed: NIH Office of Research Facilities, 2006.

6.8 Ceilings

A. Introduction

Ceilings should be smooth, moisture-resistant, and free of imperfect junctions. Surface materials should be capable of withstanding cleaning with detergents and disinfectants. Ceilings of plaster or fire-proof plasterboard should be sealed and finished with a washable paint. Exposed plumbing, ductwork, and light fixtures are undesirable unless the surfaces can be readily cleaned. Access panels are not desirable in animal housing and procedure rooms. Where access panels are required, the panels should be corrosion-resistant and gasketed.

Other requirements include:

1. Able to withstand disinfection
2. Moisture-resistant, free of cracks & crevices, and easily sanitizable
3. All penetrations must be sealed
4. Exposed pipes are not acceptable
5. Surface mounted light fixtures are desirable as they can be sealed and do not allow air exchange between the room and the above ceiling space

B. Background

Plasterboard or cement fiberboard are acceptable construction materials for ceilings. Ceilings formed by the concrete floor above are satisfactory if they are smoothed and sealed or are painted. Generally, suspended ceilings are undesirable unless they are fabricated of impervious materials and free of imperfect junctions.

C. Standard

Vivarium Ceiling Requirements	
Animal holding & procedure rooms	Cement fiber wallboard
Necropsy rooms	Cement fiber wallboard
Corridors	Cement fiber wallboard
Cage wash & sterilization areas	Cement fiber wallboard
Loading docks	Cement fiber wallboard or sus-
Support areas	Cement fiber wallboard
Offices	Suspended lay-in tile

D. References

<u>Guide for the Care and Use of Laboratory Animals 7th ed.</u> Washington, D.C.: National Academy Press, 1996.

Vivarium Design Policy and Guidelines In: Health NIo, ed: NIH Office of Research Facilities, 2006.

6.9 Ratio of Procedure Rooms to Animal Holding Rooms A. Introduction & Background:

Animal research requires that procedures be conducted on the animals. The trend is to avoid removing animals from the vivarium for the following reasons: public health — to minimize exposure of public to animals, allergens, infections; public relations & security; animal health; and to minimize the impact on research, which includes the stress of movement, and exposure to an uncontrolled environment. Support space for procedures should be provided within the vivarium. Examples of support space include: procedure laboratories, surgery suites, necropsy, radiology, imaging, and space for other equipment like irradiators.

B. Data

The recommended ratio of animal holding rooms to procedure rooms varies depending on the species to be housed and the research needs. Dedicated procedure space must be allotted for specialized procedure areas such as surgery, imaging, radiotherapy, clinical pathology, or anatomic pathology. The amount of space needed in each procedure room also varies with the intended use of the room; more space is required in rooms designated for surgery or radiology because space must be allowed for personnel to move around surgery or exam tables or radiology and imaging equipment. Consideration must also be given as to whether animals will be housed within the procedure room; rooms containing specialized research equipment are often designed to allow 1 rack of animals to be housed in the room during the procedures.

The ratio of rodent holding rooms to generic rodent procedure rooms varies from 1 procedure room to 4 housing rooms up to 1 procedure room to 8-12 housing rooms. Although the ratio of procedure rooms to animal holding rooms has steadily increased, the real ratio that should be applied is procedure rooms to cages. Assuming 420-mouse cages/animal room, the ratio of procedure room to cages should be 1:840 or 1:1,260. Dedicated procedure space may be reduced significantly if animal housing rooms are equipped with a sink and a biological safety cabinet, because many routine procedures can be performed in the housing room. Conversely, if the consequence of infection is high, additional procedure space should be considered. Ideally, procedure rooms are located in close proximity to animal holding rooms.

C. Standard

The recommended standard ratio for MDA rodent vivaria is 1 procedure room to 1260 cages. **D. References**

Hessler, J.R. 1.2 Facilities to Support Research. in *Handbook of Facilities Planning,* Vol. 2 (ed. Ruys, T.) (Van Nostrand Reinhold, New York, 1991).

Hessler, J.R. & Leary, S.L. Design and Management of Animal Facilities. in *Laboratory Animal Medicine* (eds. Fox, J.G., Anderson, L.C., Loew, F.M. & Gimby, F.W.) (Academic Press, New York, 2002).

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Meyer, J. Animal Facilities Evolve with Construction Boom. in *Laboratory Design* (R&D, Oak Brook, IL, 2006).

6.10 Location and Flood Protection A. Introduction

Research animal facilities must effectively support the research community that uses them. The location of the animal facility should be close to research laboratories and designed to enhance effective management and optimal utilization of the facility. The choice of location for any new building must include consideration of emergency management concepts. The impacts of disasters are similar, regardless of the cause of the disaster, resulting in operational disruptions and property damage. Disaster planning must be part of the basis for deciding vivarium location, both on a site and within a building. Flood protection must be included in the building design.

B. Background

The best site location for a vivarium is based on many factors. This decision is a compromise between the need to locate the facility in close proximity to the research laboratories, while isolating the animal functions for reasons of public health, public relations, security, animal health, and animal husbandry requirements. The best location for the vivarium within the building is also a compromise of competing priorities. For animal facilities that are below grade, the potential risk of flooding is only one of the components that must be considered; others include design considerations to achieve the square footage desired within the building footprint, proximity to other research components, utilities, security, dock operations, materials handling, and code requirements.

Vivarium operations are similar to hospitals and prisons in that the population of interest (in this case, the animals) can't always be readily evacuated out of the building, as is typical in other commercial buildings. For these reasons, building codes written for hospitals and prisons should be considered during vivarium planning. This may include designing reinforced interior rooms to act as safe zones within the vivarium. Other design elements may include annunciators and wiring to have longer fire resistance ratings to allow longer time for staff to move the animals to safety.

C. Data

Buildings housing animal facilities should be physically connected to research laboratory buildings when possible. Pedestrian pathways which include patient or public corridors and general employee use areas (such as cafeterias and break areas) should not exist between animal facilities and research laboratories. Potential building sites should not be within flood plains. All building entrances, penetrations, or building connections that are below grade must be waterproof and protected by flood walls or gates to one foot above the 500 year flood level. "Bathtub' style flood protection is specified for any MDA facility construction that is below grade. The foundation and exterior walls below the flood level must be waterproofed by application of reinforced membrane waterproofing. The general UT HEALTH preference is not to house research animals in a basement structure, but accepts the fact that it is unavoidable in some specific project circumstances.

D. Standard

Vivarium Location and Flood Protection	
Site location	Outside of flood plain
Location within building	At or above grade preferred
Flood level protection	One foot above 500 yr flood level
Style of flood protection	Bathtub
Waterproofing of foundation & exte-	Reinforced membrane

E. References

Hessler, **J.R.** and S.L. Leary, *Design and Management of Animal Facilities,* in *Laboratory Animal Medicine,* J.G. Fox, et al., Editors. 2002, Academic Press: New York.

Heath, S. E., *Disaster Planning for Research and Laboratory Animal Facilities,* in *Animal Welfare Information Center Bulletin.* 2000, Animal Welfare Information Center Bulletin.

Cosgrove, C., *Vivarium Planning for Disaster Preparedness,* in *Animal Lab News.* 2002.

UT HEALTH Bid Package 5 *VOL 20 CR - Waterproofing.* 2007, The University of Texas M.D. Anderson Cancer Center: Houston.

7. Specialized Facilities & Areas

7.1 Introduction & Background

An animal research facility is a specially designed building type. Functional spaces within typical vivaria include rooms/areas for animal housing, procedures, support functions, animal and materials receiving and storage. Within this specialized facility, there can be the need for even more specialized functional areas that have unique design requirements. These areas should be identified and planned for during programming. Care must be taken by the A/E Team to work with The University to identify required specialized facilities and subsequent unique design and engineering requirements. Additionally, infrastructure to support potential future specialized areas should be considered.

7.2 Data

1. Specialized functional areas of an animal facility may include:

   a) Animal holding rooms for specialized containment — typical containment facilities are designed to contain microbiological or chemical hazards. Containment of radioisotopes and other radiological hazards require specialized room shielding, radiation monitors, and areas for donning personal protective equipment. Animals involved in behavior related studies may require stricter noise controls.

   b) Specialized Procedure Rooms are procedure rooms designed for specialized studies, which may require specific design criteria. They include specializations such as
   Teaching and Training facilities, Necropsy, Clinic, and Short-term holding rooms, but also include:

Specialized Procedure Room Examples

Irradiation Facilities	Special shielding may be required for use of gamma, laser, or ultraviolet radiation. Specialized utilities, such as 220V electrical circuits, may be required by some equipment.
Imaging Facilities	Use of near-infrared or bioluminescent imaging may require specialized lighting or the ability to dim lights in selected parts of the room. Special electromagnetic field shielding may also be required in some cases.
Behavioral Facilities	Use of water filled swim tanks, conditioning chambers, mazes, or other behavioral equipment may require specialized utilities, room layouts and adjacencies, and noise controls.
Non-traditional Animal Housing	Use of frogs, fish, sea urchins, or other non- mammalian animals require housing and environmental controls appropriate to the species.

c) Other special use areas:
1. Vaporized hydrogen peroxide decontamination room
2. Laboratory space for genetic engineering, tissue culture, etc. 3. Pathology laboratories, clinical and anatomic

2. Important attributes:

a) Accessibility — specialized areas meant for general use should be able to accommodate both barrier and non-barrier animals, while also minimizing the risks of cross contamination.

b) Environmental control — typically, specialized areas must meet the same environmental standards as regular animal housing rooms. Deviation from standard is only allowed if necessary for the function of the specialized area.

c) Sanitizeable — fixtures and finishes of specialized areas must be sanitizeable, in accordance with The Guide. Deviations from standards are only allowed if necessary for the function of the specialized area.

7.3 Standard

Within this specialized facility, there can be the need for even more specialized functional areas that have unique design requirements. These areas should be identified and planned for during programming. Care must be taken by the A/E Team to work with The University to identify required specialized facilities and subsequent unique design and engineering requirements.

7.4 References

Guide for the Care and Use of Laboratory Animals 7th Edition. I.o.L.A.R. (U.S.). 1996, Washington, D.C.: National Academy Press.

Stark, S., J. Petitto, and S. Darr, *Animal Research Facility,* W.B.D. Guide, Editor. 2006, National Institute of Building Sciences: Washington D.C.
http://www.wbdg.org/design/animal research.php

8. Appendix

8.1 Typical Small Animal Holding Room - HVAC Requirements

8.1.1 Physical (using typical BSRB arrangement)	
Room Dimensions	23'-3" X6'-0"
Ceiling Height	9'
Room Volume	23'-3" x 16'-0" x 9' =3348 cubic feet
8.1.2 Air Changes	
23'-3" x 16'-0" x 9' x 20 air changes/ 60 min	1116 CFM
23'-3" x 16'-0" x 9' x 15 air changes/ 60 min	837 CFM
23-3" x 16'-0" x 9' x 10 air changes/ 60 min	558 CFM

8.1.3 Heat Loads	
Lighting	6 fixtures x 4 lamps x 32 watts =768
Ballast heat	768 watts x 1.25 J60 watts Conversion 960 watts x 3.41 = 3274 btuh Q274
Mice	126 mice x 6 racks x 5 x 1.1 btuh Q158
People	2 researchers (400 btuh +1 caretaker @i65 btuh (sensible) =1165
Equipment: 4' BSC non ducted IIA	2040
Bedding Disposal Unit	900
Vent Rack Blower Trolley	156 btuh x 3 168
8.1.4 Heat Load Calculations (Data based on 50° entering air temperature & 68.5° in the room)	
Case 1 — Static Rack System	
Lighting	3274
Mice	4158
People	1165
Equipment: 4' BCS	2040
Bedding Disposal Unit	900
Total:	11,537
Air Requirement	11,537 btuh/ 1.08 x 18.5 Q77 CFM Or 577 CFM x 60 minutes/3348 (room volume) =10.34 air changes
Case 2	

If the BSC were ducted, no people were in the room and the disposal unit is not in the room, then the room would only include the mice and lighting heat load: 3274 +4158 btuh/ 1.08 x 18.5 = 371 CFM

Or

371 CFM x 60 minutes/3348 (room volume) = 6.65 air changes

(This heat load calculation does not take into account odor and air quality)

CASE 3 - Ventilated Rack System	
Lighting	3274
Mice (heat rejected directly to the ex-	0
People	1165
Equipment: 4' BSC	2040
Bedding Disposal Unit	900
Vent Rack Blower Trolley	468
Total:	7847

Air Requirement (based on heat load)	7,847 btuh/ 1.08 x 18.5 Q92 CFM
Air Requirement *(Based on 1 ventilator per 2 Rack Requirement)*	110 CFM x 3 Q30 CFM or 330 CFM x 60 minutes/3348 (room volume) =5.91 air changes for this

8.2 Typical Procedure Room - HVAC Requirements

8.2.1 Physical (using typical BSRB layout)	
Room dimensions	26'-6" x 14-9"
Room Area	390.875 square feet
Ceiling Height	9'
Room Volume	26'-6" x 14-9" x 9' 8517.875 (3518 cubic ft)
8.2.2 Air Changes	
26'-6" x 14'-9" x 9' x 20 air changes/ 60 min.	1173 CFM
26'-6" x 14'-9" x 9' x 15 air changes/ 60 min.	880 CFM
26'-6" x 14'-9" x 9' x 10 air changes/ 60 min.	586 CFM
(Actual CFM to room is 900 CFM supply - TAB report dated 6/8/06)	
8.2.3 Heat Load Assumptions	
Lighting	6 fixtures x 4 lamps x 32 watts =768 watts
Ballast Heat	768 watts x 1.25 360 watts (960 watts x 3.41 Q274 btuh)
Mice	126 mice x 1 racks x 5 x 1.1 btuh 593
People	3 researchers @DO btuh each JCDO
Equipment: 4' BSC non ducted IIA	2040
Ultra Low	3000
Refrigerator/ Freezer	1000
Incubator	1300

Computer	500
Vent Rack Blower Trolley	156
8.2.4 Heat Load Calculations (Data based on 50° entering air temperature & 68.5° in the room)	
CASE 1	
Mice	126 mice x 1 rack x 5 x 1.1 btuh P693
Lighting	3274
People	900
Equipment: 4' BSC (recirc)	2040
Ultra Low	3000
Computer	500
Incubator	1300
Vent Rack Trolley	156
Total:	**11,863**
Air Requirement	11,863 btuh/ 1.08 x 18.5 Q93 CFM Or 593 CFM x 60 minutes/3518 (room volume) 40.1 air changes .
Air Requirement (If room is 53° not 50°)	11,863 btuh/ 1.08x 15.5 q08 CFM *(Based on maintaining 68.5° in the room)*

8.3 Animal Watering System Details

8.3.1 Stainless Steel Room Distribution System A. Standard

1. General

The stainless steel room distribution system is a water delivery piping system designed specifically for an animal automated drinking water system. The system operates normally at a low pressure of 3-5 psi, but is subjected to flushing pressures up to 50 psi.

a) This specification applies to the receiving, handling, storage, and installation of stainless steel tubing and fittings for an animal drinking water system.

b) Furnish all materials in accordance with ANSI/ASTM Standard A450 Stainless Steel Tubing and manufacture in accordance with applicable codes and standards.

c) Purchase the complete piping system from a single manufacturer. Factory cut and fabricate the tubing to system designed lengths, electro-polish, passivate and then cap and/or seal in a bag and suitably box for shipping protection. Individually bag each fitting and suitably box for shipping protection.

d) Inspect shipping cartons upon delivery for damage and material cleanliness. Report promptly to the manufacturer any damaged material.

e) Handle tubing to avoid bending or damage. Keep materials clean and free from grease and oil. Store all tubing and fittings in their original package until ready to use.

f) Store all system material in an area segregated from other construction material. Choose a location inside a building protected from any corrosive atmosphere. Limit access to protect against physical damage, loss and contamination.

B. Products

1. Room Distribution Piping and Fittings

Distributes water from a pressure reducing station into and around each animal room and to flush drain points. Pressure rating is 200 psi minimum. Use piping/fitting design to allow mechanical dismantling for repair or replacement of individual components. Soldered, brazed or adhesive bonded joints are not permitted. Electro-polish externally and passivate all water contact surfaces to attain a uniform inactive oxide surface film.

Room Distribution Piping and Fittings Standards	
Stainless Steel Welded Tubing	1. .50" OD x .035" wall 2. 316 L grade
Electro-polish/ Passivation Process	1. Electro-polish in 135°F solution of 65% phosphoric - 35% sulfuric acid 2. Passivate in 105°F solution of 20% nitric - 80% water 3. Final rinse with 125°F Reverse Osmosis water to remove all chemical residues 4. Electro-polish and passivate after all fabrication and welding

Coupling, Elbow, and Tee Fittings	1. Clean Fitting or equivalent sanitary type 2. 316 L grade stainless steel 3. ID: .43" to exactly match tubing ID 4. Electro-polish both internally and externally and passivate in accordance with 2.1.2 to a finish of 32 RA or better on **all** water contact surfaces 5. Joint Seal • High grade FDA approved silicone • Seal edge width: .05" • ID: .43" for flush internal joint 6. Ferrule: 316 Stainless Steel 7. Retainer hex nut: 303 stainless steel

2. Interconnect Station (I/C) Assembly
   a) Prefabricated piping assembly with a Quick Disconnect (Q) /half coupling fitting welded to one end
   b) Clean Fitting connection or equivalent sanitary type
   c) Design characteristics in accordance with 2.1.3 with base fitting of Q welded at branch port

Quick Disconnect (QD) Standards	
Q Type	1. Industry Standard 1/4" universal style socket
Q Base Fitting	1. .16 L grade stainless steel Fitting length of 1.03" from tubing ID to Q seal
Q Components	1. 316 grade stainless steel 2. Electro-polish both internally and externally and passivate in accordance with 2.1.2 to a finish of 32 RA or better on all machined water contact surfaces 3. Q Seal: High grade FDA approved silicone (De-bur open end of pipe to make it Clean Fitting ready for field assembly)

3. Pipe/Coupler Assembly
   a) Prefabricated piping assembly with a half coupling fitting welded to one end
   b) Clean Fitting connection or equivalent sanitary type

c) Design characteristics in accordance with 2.1.3

d) De-bur open end of pipe to make it Clean Fitting ready for field assembly

4. Interconnect Station (I/C)

Located in each animal room as shown on drawings and/or to adequately accommodate manifold connection for mobile or stationary racks or kennel/pen arrangements.

I/C Connection: Edstrom I/C Assembly with universal style **D** socket for hose connection Use Pipe/Coupler assembly for all piping runs not requiring I/C connections

5. Detachable Kynar Recoil Hose

Animal rack water supply hose assembly which can be detached from the room piping for sanitization or during periods of non-use.

Detachable Kynar Recoil Hose Standards	
Tubing coil	Black PVDF (Kynar) (3/8" OD x 1/4' ID, NSF standard 61, FDA grade, chlorine tolerance of .5 to 50 ppm)
Extended Reach	6 feet
Autoclavability	Maximum temperature of 250°F
Quick Disconnect Couplings-Universal Style	**1.** Q plug on upper end **2.** Q socket on lower end 3. 316 grade stainless steel 4. Electro-polish both internally and externally and passivate in accordance with 2.1.2 to a finish of 32 RA or better on all machined water contact surfaces 5. Push lock barb connection
Q Seal	High grade FDA approved sil-
Stainless steel spring supports	3" long both ends

6. Solenoid Flush Valve

Solenoid valve located down stream from the water supply rack connection points at the terminating end of each room distribution piping run for Room Distribution Flushing or in the flush drain header at each rack location for On-Line Rack Flushing.

Solenoid Flush Valve Standards	
Body Material	Electro-polished 316 stainless steel
Input Power	24 Volts Direct Current (VDC), 0.5 amp; Watertight junction box with connection screw connectors
Coil	Epoxy encapsulated one piece
Ports	3/8" FPT
Diaphragm	Teflon

7. Rack Flush Recoil Hose

Animal rack flush hose/check valve/fitting assembly that connects the terminating point of the rack manifold to the drain header. D plug on lower end of hose to plug into supply line/recoil hose Q socket when rack position is vacant.

Rack Flush Recoil Hose Standards	
Tubing coil	Black PVDF (Kynar) (3/8" OD x 1/4" ID, NSF standard 61, FDA grade, chlorine tolerance of .5 to 50 ppm)
Extended Reach	6 feet
Autoclavability	Maximum temperature of 250°F
Hose Fittings	1. Swivel nut with o-ring seal on upper end **2. 0** plug on lower end — Universal style 3 316 grade stainless steel - wetted parts **4.** Push lock barb connection
Stainless steel spring supports	3" long both ends
Check Valve	1 Polyproplene body 2. EPDM 0-ring seal 3. Stainless steel spring

8. Capabilities and Features

Stainless steel tubing and fittings to be passive in tap water, 10 ppm chlorinated water or 2.5 pH acidified water

a) Edstrom Clean Fitting design provides a consistent, smooth, inside diameter conduit for unobstructed water flow throughout the system piping.

b) Edstrom Clean Fitting seal design assures that no cracks or crevices exist between edge of tubing and mating fitting shoulder when fitting is fully assembled
c) Pocket created by the port in the I/C Assembly to be less than 2-1/2 tubing
diameters long to allow for water exchange during flushing and to minimize the opportunity for microbial growth

9. Execution

Perform installation with factory certified technicians on the Clean Fitting system or prequalify/train on-site technicians with factory authorized personnel. Instruct on all aspects of cutting tube, de-burring, tube bending and Clean Fitting assembly.

10. Fabrication

a) Factory de-bur ends of cut tubing so it is ready to assemble into the Clean Fitting

b) Make field cuts with a stainless steel tubing cutter supplied by the system manufacturer and used only on stainless steel and chamfer outside and inside edges per assembly instructions to remove any burrs.

c) Make square cuts to accurate lengths and assemble joints tightly.

d) Use tube bending whenever possible for corners and offsets with a bender supplied by system manufacturer and used only on stainless steel.

11. Installation and Mounting

a) Attach tubing to the wall, ceilings or other suitable support structure with 18 GA stainless steel clamps and other appropriate brackets. Use stainless steel mounting hardware.

b) Provide a 2-hole clamp at each I/C station within 2" of the **D** fitting to provide adequate rigidity and support. Provide one-hole clamps at all other mounting points where suitable support can be attained. Space clamps not to exceed 36".

c) Provide plastic stand-off spacers under each clamp for wall mounting applications to mount piping off the wall by 1/2" with plastic screw anchors and stainless steel self tap screws (#0 x 1-1/4").

d) Install the entire piping system at a consistent level throughout at a height of 84" to 96" above the floor. Limit any rises and drops.

e) Provide a stainless steel wall plate on each side of the wall for wall break penetrations. Use silicone sealant to affix the plate to the wall and to make an air tight seal around the pipe. Avoid any mechanical joints inside walls. Do not use wall sleeves.

8.3.2 Pressure Reducing Station

A. Standard

1. General

The Pressure Reducing Station is a panel assembly to provide animal drinking water at a normal operating pressure of 3-4 A-1/2 pounds per square inch (PSI) with a minimum flow of one gallon per minute (GPM).

Edstrom Model 8550 Digital Display Station with Auto Flush and Monitoring Sensors.

B. Products

1. Enclosure/Panel

All parts shall be constructed of 18 gauge 300 Series Stainless Steel, except back panel of 16 gauge, with commercial satin finish on all exposed surfaces. The two gasketed doors shall have stainless hinges at each side to swing open and provide full access to all components:

a) Surface Mount Cabinet: 16" H x 25.5'W x 6.5 D
b) Recessed Back Box: 16" **H** x 25" W x 6" D c) Recessed Door Frame:

17.5" H x 26.5" W

2. Display/Interface Module

a) Door mounted with digital readout of system pressure and LED Indicators for function status
b) Enclosure- ABS plastic, water resistant
c) 3-Character Display with pressure reading in psi, kPa/bar
d) Signal outputs for digital or network system connections
e) Output: 24vdc to solenoid valve
f) Inputs: Pressure transducer, flow switch
g) LED Indicators: High and low pressure, flow, solenoid power and service
h) Plug-in cable connectors

3. Wetted Components for Piping, Fittings, Valves, etc.

Wetted Components Standards	
Piping	1/2" O.D. Tubing- 316L Stainless Steel

Fittings	Thread/Clean Joint Compression - 316L Stainless Steel
Shut-off Valve	Ball Valve - 316 Stainless Steel
Flexible Hose	Silicone Hose reinforced with polyester braid
Inlet Connection	Clean Joint Fitting - 1/2" Tube x 1/2" male pipe thread (MPT)
Outlet Connection	Flexible Hose with Clean Joint Fitting for 1/2" Tube

4 Water Filter

5" Housing standard (other options available)

Water Filter Standards	
Housing	Polypropylene with 3/8" female pipe thread (FPT) ports
Replacement Cartridge	5 micron spun polypropylene
Flow Rate	5 GPM at 50 psi
Screen	50 mesh Stainless Steel -unfiltered model only

5. Pressure Regulator

High Flow Design

Pressure Regulator Standards	
Materials- wetted parts	316 Stainless Steel Diaphragm: Silicone, 6" diameter Seat: Silicone
Ports	1/2' MPT inlet, 3/4' MPT outlet
Pressure Capacity	75 psi (max) inlet
Low Pressure Unit	Range: 2-8 psi adjustable outlet
	Standard setting: 3 psi Flow rate: 10 GPM psi setting

High Pressure Unit	Range: 4-17 psi adjustable outlet Standard setting: 15 psi Flow rate: 14 GPM @ 0 psi setting

6. Pressure Transducer (CE Approved)
   a) Range: 0-25 psi (0.5% accuracy)
   b) Wetted Materials: 316 Stainless Steel

7. Flow Switch
   Non-Adjustable (UL Recognized)

Flow Switch Standards	
Wetted Materials	Ryton-R4 and 316 Stainless Steel
Flow Rate Actuation of Switch	80 A-20m1/min
Switch Function	N.O. (normally open with no flow)
Switch Rating	Single Pole Single Throw (SPST) .17 amp at 120 Volts AC

8. Solenoid Valve
   a) Normally closed (UL Listed)
   b) Wetted Materials: Electro-polished 316 Stainless Steel Body:
   c) Ports: 3/8" FPT
   d) Coil: Epoxy encapsulated one piece 24 volts direct current (vdc), .5 amps

8.3.3 Reverse Osmosis Water Purification System

A. Standard

1. General

   The Reverse Osmosis Water Purification System is a complete pre-engineered system designed specifically for animal drinking water applications. The water purification system is custom designed and built to meet the requirements for a specific application. Custom factors include the quality and quantity of water provided, storage tank capacity, distribution pump output, and pre-treatment and/or post-treatment options. A microprocessor controller automatically controls and monitors the system operation. V5- Watchdog ready interface is standard for remote monitoring and alarm communication.

Feedwater Requirements to the System

Local water conditions may dictate additional pretreatment to achieve specified performance	
Flow rate	12 gpm @0psi minimum
Temperature	77F (25C) ideal, 85F (30C) maximum. *Water temperature will affect permeate production rate. For a 1°F drop in temperature a 2% drop in water production is expected*

pH 5.8 - 11.0	
Chlorine Concentration Tolerance	
Cellulose Acetate (CA) Membrane Polyamide (PA) Membrane	2.0 ppm max 0.0 ppm max
Total dissolved solids	1000 mg/l max
Turbidity	5 SDI
Hardness	t5 grains per gallon
Maganese	9.05 ppm
Organics	ppm
Silicas	ppm
Iron	2 ppm in concentrate

B. Products

1. Major System Components

   a) **Reverse Osmosis Unit -** Pre-treat feedwater, process water through RO unit equipped with automated clean-in-place and flush systems, pH, conductivity and temperature monitoring, control panel with LCD graphics display and devices including pumps, piping, fittings, valves, sensors, and transmitters.

2. Pretreatment pH Buffer System maintains feedwater at pH .8-6.2

Pretreatment Standards	
Solution Metering Pump	Positive displacement, diaphragm type with stroke length and frequency adjustments
Solution Tank *(floor standing with recess for mounting solution* pump)	1. Material: polyethylene 2. Capacity: 35 gallons 3. Low level detection switch: PVC

pH Sensor/Transmitter 1)	1. Display: graphics display on controller 2. Automatic temperature compensation 3. Range: 0-14 pH 4. Accuracy: A-0.2% depending on electrode calibration
pH Probe _	Glass electrode PVDF housing with Viton seals

3. Chlorination System
Maintains feedwater at 0.3-2.0 ppm chlorine concentration for chlorine tolerant (CA) membrane only

Chlorination System Standards	
Solution Metering Pump	Positive displacement, diaphragm type with stroke length and frequency
Solution Tank *(Floor standing with recess for mounting solu-*	1. Material: polyethylene 2. Capacity: 35 gallons 3. Low level detection switch: PVC

4. Prefilter
   - a) Sized to application
   - b) Housing: polypropylene
   - c) Cartridge: 5 micron spun polypropylene

5. Reverse Osmosis Machine Cabinets and frame - floor standing

Reverse Osmosis Machine Standards	
Overall Size	60"W x 38"D x 78"H max with membranes
Six Membrane Model	60"W x 38"D x 78"H max with membranes
Five or Less Membrane Model	60"W x 35D x 78"H max with membranes
Material	300 series stainless steel
Optional Neutralization Tank	Separate floor standing assembly

6. Reverse Osmosis Pump and Membranes

Reverse Osmosis Pump and Membrane Standards

Pump/ Motor	1. Type: multistage centrifugal 2. Pump material: stainless steel 3. Motor: 208-230/460 VAC, 60Hz, 3 phase, 3 HP 4. Control: automatic with manual on/off inlet valve
Membranes	1. Type: spiral wound, 4.0" dia. x 40" length 2. Material: cellulose acetate (CA) standard; polyamide (PA) optional 3. Housing: 304 stainless steel; 4.5 dia x 49" high

7. Sensors/Transmitters and Controls

Sensor/Transmitter and Control Standards	
Inlet 3-way Valve	Type: motorized valve Wetted material: PVC w/Viton seals
Temperature sensor monitors permeate water temperature	Wetted material: 316 stainless steel
Pressure sensors/transmitter monitoring parameters	1. Pre-filter/Supply Water pressure 2. Post-filter 3. RO pump outlet 4. Final pressure (Concentrate outlet pressure from membrane) 5. Permeate line pressure
	6. Wetted material: 316 stainless steel
Flow sensor/transmitter measure flow rates	1. Concentrate to drain 2. Permeate 3. Wetted material: 316 stainless steel, PVDF, ceramic and Viton seals
Pressure sensor monitors permeate line pressure and system shuts down when over-pressure	Wetted material: 316 Stainless Steel

Permeate purity valve directs permeate flow to storage tank or drain	1. Type: 3-way motorized valve 2. Wetted material: 316 Stainless Steel w/Teflon seats
Conductivity Sensor/ Transmitter - Monitors inlet water conductivity for use in program calculations	
Display	Graphics display on controller
Mounting	Directly to inlet piping
Cell Constant	K€1.1
Range	5uS/cm-10 mS/cm
Accuracy	3% of measured value
Alarm Set Point	For high conductivity
Wetted Materials	PVDF with Viton seals & graphite
Conductivity Sensor/ Transmitter - Monitors permeate water to direct flow	
Display	Graphics display on controller
Mounting	Directly to inlet piping.
Cell Constant	K15.1
Range	0.5uS/cm-200uS/cm
Accuracy	3% of measured value
Alarm Set Point	For high conductivity
Wetted Materials	PVDF with Viton seals & stainless steel electrode
Permeate Check valve: stops back flow into permeate side of mem-	Wetted materials: 316 Stainless steel

8. Control Panel

In reverse osmosis, the cabinet operates entire system.

Control Panel Standards	
Controller	Microprocessor based
Display	64x240 character LCD graphics
Alarm	Audible with disable mode.
Alarm Warning	Messages are displayed on control panel graphics display
Remote Alarm	Relay with dry contacts and V5 connection for controller alarms; Second relay with dry contacts
Input	24VAC, 60Hz, 1 phase isolated

9. Maintenance Equipment

Provides automated operational processes for membrane maintenance

a) Automatic Flush System activates a bypass solenoid to increase water flow across the membrane automatically at preset time intervals.

b) Automatic Clean-in-place System cleans membrane with a cleaning solution automatically as required or a minimum of every 90 days.

Automatic Clean-in-place System Standards	
Cleaning solution injection assembly proportionately injects solution into water supply line to fill clean-in-place tank	
Tank	1. Material: polyethylene 2. Capacity: 18 gallons 3. Level detection switch: PVC
Process Control Valves	Fill solenoid: stainless steel
Recirculation valves	1. Motorized ball valve 2. Wetted material: PVC—inlet valve, 316 Stainless steel-CIP and permeate valve
Tank drain solenoid valve:	316 Stainless Steel
Neutralization Tank Option *Provides means to manually neutralize cleaning solution*	
Holding tank	1. Material: polyethylene 2. Capacity: 30 gallons 3. Drain Valve: PVC

10. Piping, Tubing, Fittings, and Connections

Piping, Tubing, Fittings, and Connections Standards	
Wetted Materials	1. Feed Water: PVC/CPVC/Polyproplylenel 316 stainless steel 2. Permeate water: 316 stainless steel
Sample Valves	1. Pre and post filters and concentrate flow (Ball type — PVC body) 2. Permeate flow (Needle type — 316 stainless steel)

Connections	1. Inlet: 1" FPT or 1" pipe solvent welded 2. Permeate outlet: 3/4' FPT 3. Drains: • Concentrate Drain: 3/4' FPT • CIP Drain: 3/4' FPT

11. Storage and Re-pressurization Equipment

Provides atmospheric tank storage and pump systems to accumulate the RO product water and re-pressurize for delivery through the supply header.

12. Storage Tank Assembly - Floor Standing

Floor Standing Storage Tank Assembly Standards	
Capacity	Sized to application (90-1100 gallons)
Material	1. Tank and Gasket: Polyethylene 2. Cover: Polypropylene 3. Hardware: 316 stainless steel
Seal	Bolt down cover with gasket
Level Control	Level sensing pressure sensor/transducer
Switches	Back-up overflow float switch
Air Vent Filter	0.2 micron

13. Purified Water Distribution Dual Pump Skid

Purified Water Distribution Dual Pump Skid Standards	
Type	Centrifugal
Wetted Material	1. Pump: 316L stainless steel passivated 2. Piping/Fittings: 316 stainless steel; passivated & electro-polished

Motor	1. 208-230/460 VAC, 60 Hz, 3 phase (sized to application, 1.5 - 2.0 HP) 2. Maximum 1.5 HP output pressure 55 psi el Hz; 40 psi Op Hz 3. Maximum 2.0 HP output pressure: 62 psi (0 Hz, 44 psi gi Hz 4. Transformer may be required for all other VAC applications 5. 200 VAC/60 Hz convert to 240 VAC 6. 380 VAC/60 Hz convert to 480 VAC
Motor Starter	Frame-mounted and pre-wired to motors
Floor Standing Frame	Stainless steel
Size	30"Dx36"VVx49.5"H

14. Interconnect Piping, Fittings, and Valves

Interconnect Piping, Fittings, and Valve Standards	
Piping Material	1. Feed Water: PVC/CPVC/Polyproplylene/ Brass/ Stainless steel 2. Permeate Water: 316 stainless steel
Valve Material	1. Inlet Valve: PVC with Viton seals CIP 2. Permeate Valve: 316 stainless steel with Teflon seats

15. Pressure Tank (Floor Standing)
Provides pressurized storage of RO product water

Floor Standing Pressure Tank Standards	
Capacity *(Size per application)*	1. 86-gallon tank with 25.4 gallon working capacity at 40/55psi drawdown 2. Optional 34-gallon tank with 10 gallon working capacity at 40/55psi
Wetted Material	Polypropylene, butyl - FDA approved with stainless steel fitting

Size	1. 26"D X17.2"H - (86 gallon) or 2. 22" dia x 29-1/2" **H —** (optional - 34 gallon)

16. System Maintenance Kit Provides equipment and supplies to check for proper system operation

System Maintenance Kit Standards	
Conductivity Meter	Portable battery operated meter to measure water purity
Standard Solutions	Initial supply for calibrating pH and conductivity analyzers
Chlorine Test Kit	Measures chlorine concentration
Daily Log Sheets	Tabulated forms to record operational data if unit is not monitored by V5 Watchdog

17. Capabilities and Features
    Automatic operation with a microprocessor controller to control the entire system and minimize personal attention requirements
18. System Performance
    a) Specifications are based on designated operating parameters
    b) Reject feedwater contaminants to listed levels for each membrane type

CA Membrane Reject Contaminant Percentages	
Salt Rejection	93-97%
Organic Rejection	200 MW
Bacteria Rejection	99%
Pyrogen Rejection	99%
Particle Rejection	99%

c) Assume typical water with a mixture of monovalent and polyvalent salts

d) Expect some performance variations based on water temperature and local water conditions

e) Provide feedwater within temperature range of 50-85o F (10-300C) or membrane life may be shortened. Max temperature is 104o F (40oC)

f) Produce permeate at designated rates based on 60F feed water temperature. For every 1F below 60F, expect a 2% reduction on in the permeate production shown below:

Permeate Production	
CA Membrane	0.4 - 2.4 GPM (585-3510 GPD)
PA Membrane	0.9 - 5.2 GPM (1242-7452 GPD)

g) Recover permeate at a 50% ratio of feedwater as a standard, but base actual recovery on analysis of supply water

h) Membrane life may be reduced if temperature is outside of 50-85o F (10-30oC). Maximum temperature 104o F (40oC)

19. Automated System Control

a) Activate RO machine when water level in storage tank reaches refill point

b) Activate pH pump when RO operates and monitor pH level with pH sensor/ transmitter to automatically keep feedwater adjusted to pHg.8-6.2

c) Activate chlorine pump to maintain chlorine level in feedwater at pre-established set concentration of 0.3-2.0 ppm. Prevent microbial growth internally in RO with adequate chlorination (CA membrane only).

d) Check inlet pressure to automatically shut down RO machine for pump protection if water pressure or flow is lost.

e) Check temperature of water to automatically shutdown RO machine for internal component protection if permeate water temperature rises above 100° F

f) Check conductivity of product water with sensor/analyzer for product water diversion to drain if sensor detects water quality below set purity.

g) Activate one distribution pump when pressure tank pressure reaches the cut-in set point and shut down at cut-out set point.

h) Operate two distribution pumps alternatively during run cycles to prevent stagnation from occurring.

i) Provide automatic back-up of pump operation by operating only the good pump if either pump fails

j) Display operational status on message screen.

k) Activate RO system and flush solenoid valve to automatically increase water flow across membrane at preset daily/hourly time intervals to flush sediment from membrane surfaces

l) Determine need for membrane cleaning and activate as required based on sensor readings.

m) Activate automatic clean-in-place system to clean membranes with a special solution as required or a minimum of every 3 months.

- Inject cleaning solution concentrate proportionately into RO water as it fills clean-in-place tank
- Control flow into tank with level detection switch
- Circulate solution mixture through reverse osmosis unit for preset time period
- Soak solution for preset time
- Drain solution mixture from tank
- Flush cleaning solution out of RO unit and continue to operate until acceptable purity level is attained

n) Provide daily log reporting from sensor readings and store in controller memory.

20. Automated System Monitoring

a) Display alarm conditions on controller graphics screen.

b) Activate audible buzzer and alarm message when alarm occurs.

c) Close dry contact relay for controller alarm remote transmission to another device.

d) Close dry contact relay for power loss alarm transmission to another device.

e) Allow 98 days of operational data to be stored in the controller memory.
  - View daily log data on the controller display one day at a time. Scroll to other days.
  - Allow daily log data to be transferred to an attached PC for archiving or printouts.

f) Provide data transmission to send RO operational data and alarm messages to a remote message display of a V5 Watchdog computer.

g) Provide alarm messages for abnormal conditions

- High, low and empty product water storage tank levels
- Low solution levels in pH buffer and chlorine solution tanks
- Low inlet pressure
- High feed-water temperature
- Low flow from RO pump
- High/Low pH of feedwater
- High conductivity of product water
- Distribution pump failure

8.3.4 Recoil Hose Flush Station

A. Standard

1. General

The Recoil Hose Flush Station shall be a panel assembled, self-contained unit designed for wall-mounting. It shall provide a method to internally flush up to six Detachable Recoil Hoses at one time. The flushing procedure involves connecting up to six recoil hoses to the Flushing Station and automatically flushing them with water and then evacuating the hoses with compressed air. Periodic flushing may control bacterial growth in the recoil hoses. For more effective bacterial control, the recoil hoses can be chlorine sanitized by installing a separate Chlorine Injector Station in the feed-water line to the Recoil Hose Flush Station.

2. Description of Operation

The Recoil Hose Flush Station is designed to flush up to six recoil hoses with water or a sanitizing solution (with *separate* Chlorine Injector Station) and then evacuate the hoses with compressed air. The Manual Flush Station has ball valves which are turned manually to introduce either water or air. The Automated Flush Station is equipped with a Controller with user-settable times which controls two solenoid valves. This permits the flush sequence to be completed by just pushing one button. The Controller has both 2- cycle and 4-cycle operation. Two-cycle operation has the capabilities to control the length of a plain water flush and air evacuation. Four-cycle operation is selected when the water supply is chlorinated to sequence through 4 timed steps: initial flush, soak period, second flush, and air evacuation.

Recoil Hose Flush Station Operating Parameters	
Water Supply Pressure	40-60 psi/75 psi maximum
Water Supply Flow	4 gpm minimum

Compressed Air	Clean, oil free
Compressed Air Pressure	15-60 psi/75 psi maximum
Compressed Air Flow	10 cfm (cubic feet per minute)

B. Equipment, Components, and Standards

Recoil Hose Flush Station Equipment and Component Standards	
Panel Size	Approximately 35" **H** x 25" W
Material	300 series 18 gauge stainless steel with pre-punched holes for mounting screws
Wetted Components	1. Piping: 1/2" OD Tubing - 316SS 2. Fittings: Thread/Compression Type 316SS 3. Check Valves - air & water inlet - Stainless Steel
Click Disconnects	1. Material: 316 Stainless steel (wetted parts only) 2. Style: Universal with ball check in quick disconnect **D** plug
Valves	Solenoid operated Stainless Steel 115 VAC 50/60 Hz normally-closed pilot-operated type.
Plumbing Connections	1. Water/Air Inlet: Flange with swivel nut for 1/2" Male Pipe Thread (MPT) adaptor 2. Drain: 1/2" OD 316 Stainless Steel Compression fitting with 15' of drain piping

Recoil Hose Flush Station Control Panel Specifications (Model 5480 only)

Enclosure	NEMA 12, Size 10-1/2" H x 8-1/2" VV x 5" D 304 Stainless Steel
Electrical Requirements	115 volts alternating current (VAC), 50/60 Hz, single phase, 1 amp with ground fault interrupter (GFI circuit) required (must be hard wired)
GP Controller Features	1. Start and Reset Buttons 2. 32-character LCD 3. Power and Alarm indicator lights 4. Audible Alarm with Silence Button 5. Keypad with dome switches 6. Selectable 2-cycle and 4-cycle flush modes 7. Cycle settings: • Flush 1: Preset to 2 minutes; range is 1-9 minutes • Soak (4-cycle only): Preset to 30 minutes; range is 1-99 minutes • Flush 2 (4-cycle only): Preset to 2 minutes; range is 1-9 minutes • Air Evacuate: Preset to 15 seconds; range is 1-99 seconds

8.3.5 Chlorine Injection Station A. Standard

1. <u>General</u>

The Chlorine Injector Station shall be a panel assembled self-contained unit designed for wall mounting. It will provide chlorinated water for the Recoil Hose Flush Station and other applications where the water flow rate is constant. Both units are UL LISTED.

The Chlorine Injection Station is for use only with auto Recoil Hose Flush Station with a Controller to provide control functions. The unit shall include a metering pump, a 4-gallon tank, a flow switch, a mixing chamber, electrical controls and wall mounting hardware. All components shall be compatible with either tap water or purified water supply. The approximate dimensions are 38" H x 35"W x10" D.

2. <u>Description of Operation</u>

The Chlorine Injector Station is designed to mix a sodium hypochlorite solution into the water flow. When water flow is detected by the flow switch, the metering pump will start
injecting the chlorine solution. The pump will keep operating until water flow stops. The sodium hypochlorite solution is stored in a 4 gallon polyethylene tank.

3. Operating Parameters

Chlorine Injection Station Operating Parameters

Water Supply Pressure	1. 75 psi maximum 2. Recoil Hose Flushing - 40-60 psi
Water Supply Flow	1. 0.25 gpm minimum 2. Recoil Hose Flushing - 4 gpm minimum 3. Water Supply Temperature: 40-120°F
Chlorine Concentration	0-20 ppm, adjustable ranges
Treatment Capacity Per Tank	Half full tank will treat approximately 1350 gallons of water at 20 ppm

B. Equipment, Components, and Standards

Chlorine Injection Station Equipment and Component Standards	
Panel	1. Size: Approximately 23.5" H x 35 W 2. Material: 300 series 18 gauge stainless steel with pre-punched holes for mounting screws
Piping, Fittings, Valves, etc.	
Piping	1/2" OD Tubing - 316SS
Fittings	Thread/Compression Type - 316SS
all Valve	3/8" FPT - 316SS
Inlet Connection	Flange with swivel nut for 1/2 MPT adaptor
Outlet Connection	1/2 OD compression fitting
Flow Switch	
Activation Flow Rate	.25 gallons/minute minimum
Construction	PVC with hermetically sealed switch

Electrical Rating	120 Volts AC, 50/60 Hz, (.5 amps maximum), normally closed.
Mixing Chamber	
Construction	Polypropylene; 3/8 NPT ports
Mixing Tube	PVC Pipe
Chlorine Injection Pump/Tank Standards	
Construction	Glass fiber reinforced thermoplastic. All exposed fasteners are stainless steel
Flow Rate	Maximum capacity 26 ml/minute, maximum pressure 140 psi
Electrical Rating	1. 120 volts AC, 50/60 Hz 2. Average input power is 168 watts @ maximum speed
Suction and Injection	1. A foot valve with integral strainer is provided for the suction line 2. The injection point has an anti-siphon check valve with 1/2" NPT male connection
Solution Tank	1. Capacity: 4 gallon, size 12" x 6" x 12" 2. Material: Polyethylene
Control Panel (Model 301 only)	
Enclosure	NEMA 12, Size 10"x 8" x 6"; 304 Stainless Steel

Electrical Requirements	120 Volts AC, 50/60 Hz, single phase, 1 amp with ground fault interrupter (GFI circuit) required (must be hard wired)
Controls	Selector switch for chlorinated water or plain water
Junction Box	
Enclosure	Weatherproof, aluminum 2-gang switch box
Electrical Requirements	Must be powered from GP Controller on auto Recoil Hose Flush Station
Controls	Must be controlled by GP Controller on auto Recoil Hose Flush Station

8.3.6 Rack Manifold Flush Station A. Standard

1. General

The automatic rack manifold flush station shall be a panel assembled self-contained unit designed for wall mounting. It will provide chlorinated water at an operating pressure of approximately 17 psi for flushing and sanitizing mobile rack manifolds.

The flush station shall consist of a metering pump, a 4 gallon tank, a flow switch, an inlet water filter/mixing tube, pressure regulator, wall mount hardware, a poly recoil hose with quick disconnect on the outlet side for connection to the mobile rack watering manifold and a solenoid valve and Controller for either 1-cycle or 3-cycle operation. The approximate dimensions are: 40" H x 37" VV x 10" D.

Automated Flush Station with stainless steel solenoid valve and Controller, for tap water or purified water supply

2. Description of Operation

The rack manifold flush station is designed to mix a sodium hypochlorite solution into the water flow. When a rack manifold is connected to the rack manifold flush station and water flow is detected by the flow switch, the metering pump will start injecting the chlorine solution. The pump will keep operating until the preset time has elapsed (automatic units) or water flow stops. The sodium hypochlorite solution is held in a 4- gallon polyethylene tank.

The automated rack manifold flush station uses the GP Controller to control and monitor both 1-cycle and 3-cycle operation. One-cycle operation controls the length of flush time only. Three-cycle operation sequences through 3 timed steps: initial flush, soak period, and final flush.

3. Operating Parameters

Rack Manifold Flush Station Operating Standards

Water Supply Pressure	25 psi minimum/75 psi maximum
Water Supply Flow	2 gpm minimum
Water Supply Temperature	40-1200F (4 - 4900)
Flush Station Output Pressure	15-17 psi
Flush Station Output Flow	0.25 gpm minimum, 1.0 gpm typical
Chlorine Concentration	20 ppm recommended, adjustable
Flush Cycles per Tank *This is 180-480 manifold flush cycles depending on flush time and flow rate.*	One full tank will treat approximately 720 gallons of water at 20 ppm or 1300 gallons at 10 ppm.

B. Equipment, Components, and Standards

Rack Manifold Flush Station Equipment and Component Standard	
Panel	1. Size: Approximately 23.5"H x 35"W 2. Material: 300 series 18 gauge stainless steel with pre-punched holes for mounting screws
Piping, Fittings, Valves, etc.	
Piping	1/2" OD Tubing-316SS
Fittings	Thread/Compression Type-316SS
Valves	1. Solenoid operated Stainless Steel 115 VAC 50/60 Hz; normally closed pilot- operated type and stainless steel ball type 2. Check Valves: 316 Stainless Steel 3. Inlet Connection: Flange with swivel nut for 1/2 MPT adaptor
Flow Switch	
Activation Flow Rate	.25 gallons/minute minimum
Construction	PVC with hermetically sealed switches
Electrical Rating	115 Volts AC, 50/60 Hz (.50 amps maximum), normally closed
Mixing Chamber	
Construction	Polypropylene with 3/8 NPT ports
Mixing Tube	PCV pipe
Chlorine Injection Pump/Tank	

Construction	1 Glass fiber reinforced thermoplastic 2. All exposed fasteners are stainless steel
Flow Rate	1. Maximum capacity 31 ml/ minute
	2. Maximum pressure 100 psi
Electrical Rating	1. 115 volts AC, 50/60 Hz 2. Average input power is 130 watts at maximum speed
Suction and Injection	1. A foot valve with integral strainer is provided for the suction line 2. The injection point has an anti-siphon check valve with 1/2" NPT male connection
Solution Tank	1. Capacity: 4 gallon, Size 12"x 6" x 12" 2. Material: Polyethylene
Pressure Regulator	
Construction	316 Stainless steel wetted parts
Ports	*112'* MPT inlet, 3/8" MPT outlet
Pressure Capacity	75 psi maximum inlet, 17 psi outlet
Flow	17 psi - 13 gpm
Recoil Hose Assembly	
Hose Material	Polyurethane - 3/8" C.D. by **1/4"** ID, black, FDA Grade
Hose Reach	10 feet
Quick Disconnect	Universal Style stainless steel socket
Control Panel	
Enclosure	NEMA 12, Size 10" H x 8" W x 6" D 304 Stainless Steel Construction
Electrical Requirements	115 volts AC, 50/60 Hz, single phase, 1 amp with ground fault interrupter (GFI circuit) required (must be hard wired)

Controls	Manual: Selector Switch for Chlorinated Water or Plain Water Automatic: GP Controller features 1. Start and Reset Buttons 2. 32-Character LCD 3. Power and Alarm indicator lights 4. Audible Alarm with Silence Button 5. Keypad with dome switches 6. Selectable 1-cycle and 3-cycle flush modes 7. Cycle settings: • Flush 1: preset to 2 minutes; range is 1 - 9 minutes • Soak (3-cycle only): Preset to 30 minutes; range is 1 - 99 minutes • Flush 2 (3-cycle only): Preset to 2 minutes; range is 1 - 9 minutes

9. Glossary of Terms

1. **A/E —** and acronym referring to the Architecture and Engineering team
2. **AAALAC, International -** an acronym referring to the Association for Assessment and Accreditation of Laboratory Animal Care, International
3. **AHRs —** an acronym for Animal Housing Rooms
4. **AHU —** an acronym commonly referring to an air handling unit
5. **ARSAC —** an acronym referring to the Animal Research Strategic Advisory Committee
6. **ASC —** an acronym for application specific controllers
7. **ASHRAE -** American Society for Heating, Refrigeration, and Air Conditioning Engineers
8. **ASME —** American Society of Mechanical Engineers
9. **ASTM International —** American Society for Testing and Materials
10. **BAS —** Building Automation System
11. **BCuP5 -** a metal alloy used in welding copper pipe
12. **BOD —** an acronym that stands for Basis of Design
13. **BREB -** a UT HEALTH acronym referring to the Basic Research & Education Building on the Bastrop Campus
14. **BSC —** biological safety cabinet
15. **BSC IIA2 —** biological safety cabinet that provides personnel, product, and environmental protection; self-exhausts approximately 30% back into the room and re-circulates the rest.
16. **BSC I1B1 -** biological safety cabinet that provides personnel, product, and environmental protection; exhausts more than 50% via a remote ventilated system (i.e., building exhaust) and re-circulates the rest. Also known as 70% exhaust.
17. **BSC IIB2 -** biological safety cabinet that provides personnel, product, and environmental protection; exhausts 100% via a remote ventilated system (i.e., building exhaust). No recirculation.
18. **BSL1 —** Biosafety Level 1, basic level of protection appropriate for well-characterized agents not known to cause disease in healthy humans
19. **BSL2 —** Biosafety Level 2, moderate risk agents that cause human disease by ingestion or through

percutaneous or mucous membrane exposure; emphasis on precautions with needles and sharp instruments

20. **BSL3 —** Biosafety Level 3, high, possibly lethal, risk agents that cause human disease by inhalation exposure; emphasis on control of aerosols
21. **BSL4 —** Biosafety Level 4, high individual risk of life-threatening disease by the aerosol route and for which no treatment is available
22. **BSRB** George & Cynthia Mitchell Basic Sciences Research Building
23. **CABIR -** a UT M. D Anderson Cancer Center acronym referring to the Center for Advanced Biomedical Imaging Research Building
24. **CAP type II -** College of American Pathologists (CAP), laboratory reagent grade water which maintains 1,000 colonies of bacterial per ml of water maximum, and the electrical resistance of the water may not drop below 2 Megohms at the outlet.
25. **CCTV -** an acronym that refers to closed circuit television
26. **CFM -** cubic feet per minute, a measure of air flow
27. **CFR -** Code of Federal Regulations
28. **CMU -** an acronym referring to concrete masonry units
29. **CO_2-** Periodic table symbols for carbon dioxide
30. **CPVC -** chlorinated polyvinyl chloride, a type of plastic commonly used for water distribution
31. **dB -** abbreviation for the word "decibel," which is used in reference to a unit or quantitative measurement for sound
32. **DDC -** an acronym for direct digital control
33. **DVMS -** Department of Veterinary Medicine and Surgery
34. **EH&S -** a UT HEALTH acronym referring to the Department for Environmental Health & Safety
35. **EPDM gaskets -** gaskets made of Ethylene propylene diene monomer
36. **°F -the** universal symbol for Degrees Fahrenheit
37. **FPM-** feet per minute
38. **fps -feet** per second
39. **FRP -fiberglass** reinforced plastic
40. **ft -** abbreviation for the measurement feet, equaling 12 inches
41. **FTE -** Full time equivalent - the measure of one full time employee's work time
42. **GHz -** International System of Units abbreviation for "gigahertz," which means one billion cycles per second"
43. **GLP -** an acronym referring to good laboratory practices
44. **GMP -** guaranteed maximum price or good manufacturing practice
45. **GPM -** gallons per minute
46. **HEPA -** and acronym for high efficiency particulate air filter
47. **HIPAA -** an acronym for Health Insurance Portability and Accountability Act enacted by the U.S. Congress in 1996.
48. **HVAC -** heating, ventilation, and air conditioning
49. **Hz -** International System of Units abbreviation for "hertz," which means "one cycle per second"
50. **I.R.I. -** Industrial Research Institute
51. **IDF -** intermediate distribution frame, a cable rack that interconnects and manages the telecommunications wiring between a main distribution frame and workstation devices.
52. **IEEE -** Institute of Electrical and Electronics Engineers, Inc.
53. **IS -** a UT HEALTH acronym referring to the Information Security team on a project
54. **kV -** kilovolt, one thousand volts
55. **LN2 -** liquid nitrogen
56. **mA -** one thousandth of an Ampere, which is a unit of measure of electrical current produced in a circuit by 1 volt acting through a resistance of 1 Ohm.
57. **MBC -** an acronym for master building controllers
58. **Mbps -** an acronym for megabytes per second

59. **MCC -** an acronym that refers to motor control centers
60. **MEC -** an acronym for modular equipment controllers
61. **MEP -** standard industry abbreviation for "Mechanical, Electrical, and Plumbing," usually used as a noun to refer to the company/contractor providing the engineering of those services.
62. **micron -** unit of measure equaling 1,000,000th of a meter or approximately 0.00003937 inches.
63. **NEC -** an acronym referring to the National Electric Code
64. **NFPA -** National Fire Protection Association
65. **NIH -** an acronym for the National Institute of Health
66. **NIST -** National Institute of Standards and Technology
67. **Nm -** Newton meter, a compound unit of torque corresponding to the torque from a force of one Newton applied over a distance of one meter; dimensionally equivalent to a joule
68. **NRC -** National Research Council
69. **0_2 -** Periodic table symbol for oxygen
70. **PC/DOS -** operating system for IBM type computers
71. **pH -** symbol used to represent the measurement scale that determines the acidity or basicity of hydrogen ions in a solution.
72. **PIR -** an acronym for "Passive Infra-Red" sensor, which is an electronic device that measures infrared light radiating from objects in a field of view
73. **PM -** standard industry abbreviation for the title of Project Manger
74. **PRS -** an acronym for pressure reducing station
75. **PRV -** an acronym that stands for pressure reducing valve
76. **psi -** pounds per square inch
77. **psig -** and acronym referring to pounds per square inch gauge
78. **PVC -** an acronym for polyvinyl chloride - a material used in constructing a variety of materials from plumbing fixtures to vinyl siding.
79. **RH -** relative humidity
80. **RO System -** reverse osmosis water generating equipment and distribution piping
81. **RTD -** resistance temperature detector, a wire-wound and thin film device that measures temperature through the physical principle of the positive temperature coefficient of electrical resistance of metals.
82. **SCFM** - standard cubic feet per minute, the volumetric flow rate of gas corrected to "standardized" conditions of temperature, pressure, and relative humidity
83. **SMACNA -** Sheet Metal and Air Conditioning Contractors National Association
84. **STC** - Society for Technical Communication
85. **TDLR -** an acronym for the Texas Department of Licensing and Regulation
86. **UL -** Underwriters Laboratory
87. **UPS -** an acronym for uninterruptible power systems
88. **UT HEALTH** - Acronym referring to the University of Texas Health Science Center, San Antonio.
89. **VMS -** vivarium management system
90. **VSD -** an acronym for variable speed drives
91. **Wi-Fi -** an abbreviated term that refers to wireless fidelity which is a method through with radio waves transmit signals.

END OF SECTION 13 00 00 00

SECTION 14 00 00 – CONVEYING EQUIPMENT

1.1 Purpose

A. Scope of Standard

1. This standard provides general guidance concerning the specific preferences of UT Health for the elevator, escalator, dumbwaiter, platform lift, and material lift basic requirements.
2. This document is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer/architect is to apply the principles of this section and the ones that follow so that the University may achieve a level of quality and consistency in the design of its facilities. Deviations from these criteria must be justified through Life Cycle Cost Analysis (LCCA) and submitted to the Owner’s Project Manager for approval.
3. UT Health recognizes that project conditions and requirements vary, thus precluding absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these criteria will govern the design and specifications for UT Health projects.

1.2 General

A. ELEVATOR BASIC REQUIREMENTS

1. Machine-Room-Less elevators are expressly prohibited at UT Health.
2. Elevators shall utilize non-proprietary controls for operational, motion, and motor controls; any ancillary equipment shall also be non-proprietary. The design of elevator systems shall give preference to parts that will minimize the cost of future replacement parts.
3. Each elevator shall be provided with one set of "as built" electrical wiring diagrams laminated on both sides of each sheet with heat-applied clear plastic, and one electronic copy of the "as built" wiring diagrams.
4. Elevators shall be designed and built to have a minimum component service life of thirty (30) years.
5. Elevator motors shall have a Class IE2 efficiency rating or higher.
6. Elevator motors shall:
   a. be rated for elevator duty;
   b. one hundred twenty (120) starts per hour;
   c. have class H or better insulation of the windings.
7. The elevator motor drive shall recover potential energy released during motion and return it to the power grid. (Regeneration)
8. Traction elevators shall use gearless machines. If a geared machine is used the transmission shall not reduce the efficiency of the combined motor/transmission below that shown for the gearless Class IE2 motor.
9. The rated speed for elevators shall be a minimum of:
   a. For travel distances of less than 15 feet (4.6m), 125 FPM (38.1 m/min)
   b. For travel distances of 15 feet (4.6m) to 40 feet (12.2m), 200 FPM (61 m/min)
   c. For travel distances 40 feet (12.2m) to 100 feet (30.5m), 350 FPM (106.7 m/min)
   d. For travel distances greater than 100 feet (30.5m), 500 FPM (152.4 m/min) or greater
10. The driving machine brake, emergency brake, and/or rope gripper shall have a provision to seal the means of adjusting the holding capacity, to prevent changing the adjustment without breaking the seal.
11. The elevator machine shall be equipped with a device to manually release the drive machine brake

in the event of a total power failure of both the normal and emergency power systems.

12. Hydraulic elevator machines shall:
    a. Power units shall be provided with secondary containment for the full capacity of the oil tank.
    b. The machine shall utilize a solid state drive to regulate the up-direction speed with either closed or open-loop feedback.
    c. The drive machine shall recover potential energy released during motion and return it to the power grid.
13. Elevators shall have a minimum capacity of 3500 pounds and be of such a size and arrangement to accommodate an ambulance stretcher, 24 inches by 84 inches (610mm by 2134mm) with not less than 5-inch (127mm) radius corners, in the horizontal open position. (Building code requires only one elevator that services all floors meet this.)
14. Elevators shall be provided with center opening doors forty-two (42) inches wide minimum.
15. All electrical wiring that passes through or over metal panels shall be protected from abrasion.
16. All light sources for elevator cab interior, machine/control rooms/spaces, pit, and hoistway shall have an efficacy greater than or equal to fifty (50) lumens/watt and comply with the requirements in Division 26.
17. The elevator cab shall be illuminated at not less than 54 lx (5 fc), measured at the car controls, platform, and car threshold (essentially everywhere inside the cab- per TAS), and shall have an efficacy greater than or equal to fifty (50) lumens/watt and comply with the requirements in Division 26.
18. Cab ventilation shall have an efficacy greater than or equal to 3.0 CFM per watt (0.085 m^2/min./watt).
19. Air conditioning conforming to the following shall be provided when an elevator has glass walls and is exposed to direct sunlight:
    a. There shall be a minimum air handling capacity to provide one air change per minute based on the net inside car volume.
    b. An auxiliary power source capable of providing the minimum air handling capacity for a continuous period of at least two (2) hours shall be provided.
    c. The cooling capacity shall maintain the temperature inside the elevator cab below eighty (80°F) degrees Fahrenheit with the maximum number of persons allowed based on capacity.
20. Elevator controls shall be capable of automatically switching to standby mode during light traffic situations. The controls shall automatically turn off the car light and fan to save energy.
21. The elevator controller shall interface with the University's remote monitoring system.
22. The elevator controller shall be compatible with the card reader security system used by the University.
23. The elevator controls shall be compatible with the emergency power system when provided. Selector switches shall be provided in the fire control room and/or elevator lobby when required due to the limited capacity of the emergency power system.
24. Elevators shall be provided with an audible signaling device, operable from a switch marked "ALARM" which is located adjacent to the button to activate the phone.
25. The audible device shall have a sound pressure rating of not less than eighty (80) dBA nor greater than ninety (90) dBA at ten (10) feet; shall be located to be heard inside the car and outside the hoistway; for elevators with a travel greater than one hundred (100) feet there shall be an audible device mounted on the car and a duplicate device mounted at the designated level; the device shall be capable of operating for a minimum of four hours in the event that normal power fails.
26. Elevator Emergency Control buttons (Alarm and Phone) shall have their centerlines at thirty-five (35) inches minimum above the finished floor to comply with TAS. The maximum height of the operable parts of the Emergency Control buttons shall be thirty-eight (38) inches above the finished floor (AFF).

27. Alarm, Phone, Door Open, and Door Close push buttons shall be placed to have the lowest operable part of the button above 34 inches AFF, and have the highest operable part below 38 inches AFF.
28. The handrail if provided shall conform to TAS sections 505.4, 505.5, 505.7, 505.8, and 505.9.
29. Car and counterweight guides shall be a roller.
30. Glass in an elevator hoistway and/or in elevator cars shall comply with IBC section 2409, and ASME A17.1/CSA B44 section 2.14.1.8
31. Provide a TAS-compliant telephone or intercom in the elevator cab, which connects to a 24-hour maintained location and operates for a minimum of four hours when normal power is lost. The two-way communication means within the car shall be provided with a means to verify the operability of the telephone line.
32. Each elevator shall be marked with a unique alphabetical, numerical, or alphanumerical Identification:
    a. On any panel and/or switches required to be in the Fire Command Center and;
    b. At least one half (½) inch in height on the car operating panel and;
    c. At least two (2) inches in height;
        1) on both door jambs of every elevator at the designated level directly below the floor designations and;
        2) on both door jambs of every elevator at the alternate landing directly below the floor designations and;
        3) at the means necessary for tests and;
        4) at the means to trip and reset remote governors and;
        5) on the crosshead or car frame so that it is visible from the hoistway landing above and;
        6) on the mainline disconnect switch and;
        7) on the governor and;
        8) on the selector and;
        9) on the controller and;
        10) on the MG set and;
        11) on the driving machine and;
        12) on any separately enclosed control components, (e.g., motor circuit transformers, dynamic braking resistors, line rectifiers, or chokes) and;
    d. The hoistway side of every landing door shall have floor designations at least four (4) inches in height marked at the top and bottom of the leading edge of the door (center opening doors need only have markings on one (1) door at each landing).
33. Each elevator shall be provided with a listed Demarcation box, Unity Manufacturing Type 1- UL 50 and 50E with the optional back panel and standard coin latch (or equivalent on approval by UEM Elevator Manager), measuring 24 x 24 x 8 ⅝ inches equipped with:
    a. Terminals for connecting fire alarm inputs
    b. A separate branch circuit supplying two (2) 110VAC duplex receptacles
    c. Terminals for connection to card reader security
    d. Terminals for connection to a car telephone
    e. Terminations of data cables required for card reader security, and for remote monitoring of elevator controls

1.3 Demolition

A. All demolitions or modifications to existing systems shall be coordinated through the Owner’s Project Manager. Demolition drawings are based on casual field observation and existing record documentation. The accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements are as shown on the Drawings. The Contractor shall be responsible for reporting discrepancies to the Engineer before disturbing the existing installation.

B. Coordinate the scope of demolition for the project. Factors to include in determining the scope of demolition are:

1. Minimize impact on areas outside the scope of work;

2. Where existing infrastructure is no longer required due to renovation, remove as much existing conduit and boxes as possible to provide a final clean installation that is both safe and identifiable to maintain;
3. All wiring that is no longer required will be removed as part of demolition; No energized and terminated wires shall remain at the conclusion of construction;
4. Items/areas requiring temporary power;
5. Updated and complete panelboard directories are required at the conclusion of construction;
6. Areas impacted by outages and or phases of construction;
7. Coordinate with UT EHS prior to any coring operations or demolition for testing of hazardous materials.

1.4 Design requirements

Submit to the Project Manager: **PRIOR TO THE START OF THE PROJECT**

A. Shop Drawings (REQUIRED)

Shall Include the following information:

1. The location of components in the machine room. Arrange the machinery so that moving elements and other equipment can be removed for repairs without disturbing other components. Arrange the equipment for a clear passage through doors and access doors.
2. The locations for the connections of the cab lights and telephone in hoistway and machine room.
3. The location of access doors, entrance doors, and frames.
4. The electrical working clearances.
5. The mechanical working clearances.
6. The location of the machine room air conditioning and routing of all piping to and from the unit.
7. The expected heat dissipation of the elevator equipment in the machine room.
8. The electrical characteristics and connection requirements.
9. The manufacturer's specifications for the elevator controller.
10. The manufacturer's specifications for jack assembly.
11. The manufacturer's specifications for door operator.
12. The manufacturer's specifications for control fixtures.
13. The design drawings and specifications for the machine room shunt trip power module with all of the required interface contacts.
14. Samples: Illustrate cab interior finishes and car and hoistway door and frame finishes.
15. The maximum rail bracket spacing.
16. The estimated vertical forces on the guide rails on the application of safety or other retarding device.
17. In the case of freight elevators for class B or C, the horizontal forces on the guide rail face during loading and unloading, and the maximum horizontal forces in a post-wise direction on the guide rail faces on the application of the safety device.
18. The size and weight of any rail reinforcement.
19. The total static and impact loads imposed on machinery and sheave beams, supports, and floors or foundations.
20. The impact load on buffer supports is due to buffer engagement at the maximum permissible speed and load.
21. Where compensation tie-down is applied, the load on the compensation tie-down supports.
22. The total static and dynamic loads from the governor, ropes, and tension system.

23. The horizontal forces on the building structure stipulated by ASME A17.1 2.11.11.8 and 2.11.11.9- forces imposed by the hoistway doors and their safety retainers.

B. Specifications

  1. Specifications for each elevator shall be prepared using these design CRITERIA;

  2. The specific use of the building;

  3. The manufacturer’s requirements;

  4. The current Fire, Building, Electrical, Plumbing, Mechanical, Energy Conservation, Accessibility, and Elevator Codes;

  5. The specific needs of the building’s occupants;

C. Design Review

  1. The design review shall have the following stages:

    a. Schematic design review

    b. Preliminary design review

    c. Interim design review

    d. Final design review

1.5 Preferred PRODUCTS

A. Elevators

  1. Acceptable suppliers

    a. Elevator controllers
      1) Motion Control Engineering (MCE)
      2) GAL
      3) Smartrise
      4) Virginia Controls
      5) Elevator Controls (EC)

    b. Hydraulic Systems
      1) Motion Control Engineering (MCE)
      2) MEI Total Elevator Solutions
      3) Custom Elevator Manufacturing Company (CEMCO)
      4) Elevator Equipment Corporation (EECO)
      5) Boremax
      6) Maxton Manufacturing Company

    c. Traction systems
      1) Hollister Whitney
      2) Imperial Electric
      3) Torin Drive International

B. Escalators

  1. Acceptable suppliers

    a. Tejas Elevator Company
    b. Schindler Elevators & Escalators
    c. Oracle Elevator
    d. Otis Elevator Company
    e. Ameritex
    f. Thyssen Krupp
    g. Fujitec
    h. Mitsubishi Electric Elevators and Escalators

  - **i.** Kone

C. Dumbwaiters

1. Acceptable suppliers
   - **a.** Waupaca
   - **b.** Powerlift Dumbwaiters, Inc.
   - **c.** Matot
   - **d.** Gillespie Corporation
   - **e.** CITI Elevator

D. Material lifts

1. Acceptable suppliers
   - **a.** CITI Elevator
   - **b.** PFlow Industries Inc.
   - **c.** Gillespie corporation

E. Platform lifts

1. Acceptable suppliers
   - **a.** Bruno
   - **b.** Garaventa
   - **c.** Savaria

2. Approved Uses of Platform lifts
   - ***a.*** *Platform Lifts are to be used strictly for accessibility for those who have a mobility impairment.*

1.6 Installer Qualifications

A. The Installation Contractor shall have maintained an organization in continuous operation for at least the past five (5) years that is capable of installing the elevators listed. The Installation Contractor shall have operated an Elevator and Escalator maintenance service business in San Antonio, TX with office and warehouse facilities for a minimum of five (5) years prior to the bid date of this project. Bidders shall provide proof they have maintained an office with a storefront mailing address over the last five (5) years in San Antonio, TX prior to contract award.

B. The Installation Contractor shall provide documentation of the qualified personnel available at San Antonio, TX to ensure proper installation and fulfillment of maintenance and/or repair service required for the warranty period on a 24-hour emergency call basis. Journeyworkers (installers or mechanics), and Apprentices (helpers) shall have training in the field of Elevator and Escalator Installation. The training shall follow a nationally recognized program approved by the U.S. Department of Labor Office of Apprenticeship. To ensure that work and training is performed in a safe and consistent manner the numeric ratio of Apprentices to Journeyworkers shall be one (1) Apprentice to one (1) Journeyworker. At no time shall the ratio of Apprentices to Journeyworkers be exceeded.

C. The Maintenance Contractor shall submit with the bid written documentation of the Apprenticeship Program as submitted to the registration agency (U.S. Department of Labor Office of Apprenticeship) required by 29 CFR parts 29 and 30.

D. The Maintenance Contractor shall submit documentation of Journey level workers have successfully completed the requirements set forth in the Apprenticeship Program.

E. The Maintenance Contractor shall submit upon request an Apprenticeship Agreement and/or documentation of the competencies achieved by each Apprentice.

F. The Maintenance Contractor's employees shall include qualified experienced supervisory personnel to guarantee satisfactory performance of the contract. The Maintenance Contractor shall furnish a statement declaring the direct employment of the necessary personnel, organization, and local facilities to fulfill the services and conditions required under these criteria.

G. Consideration will not be given to bids submitted by a firm or corporation that has established an unsatisfactory record of performance in connection with installation, inspection, renovation, and/or repair of Elevator Equipment on former projects. The University reserves the right to determine the competency of the Installation Contractors being considered for the award of this contract.

1.7 codes and standards

A. American Architectural Manufacturers Association (AAMA)
   1. AAMA 607.1: Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum

B. American Society of Mechanical Engineers (ASME)
   1. A17.1 Safety Code for Elevators and Escalators
   2. A17.2 Guide for Inspection of Elevators, Escalators, and Moving Walks
   3. A17.3 Safety Code for Existing Elevators and Escalators
   4. A17.5 Elevator and Escalator Electrical Equipment
   5. A17.6 Standard for Elevator Suspension, Compensation, and Governor Systems
   6. A18.1 Safety Standard for Platform Lifts and Stairway Chairlifts
   7. QEI-1 Standard for the Qualification of Elevator Inspectors

C. American Plywood Association (APA)
   1. Product Guide-Grades and Specifications

D. American Society for Testing and Materials (ASTM)
   1. A36: Structural Steel
   2. A167: Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet and Strip
   3. A325: High Strength Bolts for Structural Steel Joints
   4. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
   5. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
   6. A490: Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
   7. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes
   8. A501: Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
   9. A525: Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, General Requirements
   10. B138: Manganese Bronze Rod, Bar, and Shapes
   11. B209: Aluminum-Alloy Sheet and Plate
   12. B221: Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and tubes
   13. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass

E. International Code Council (ICC)
   1. International Building Code
   2. International Energy Conservation Code
   3. International Existing Building Code
   4. International Fire Code
   5. International Green Construction Code
   6. International Mechanical Code
   7. International Plumbing Code
   8. ICC A117.1 Accessible and Usable Buildings and Facilities

F. National Electrical Manufacturer's Association (NEMA):
   1. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Non-decorative.
   2. LD-3: High-Pressure Decorative Laminates.
   3. MG1: Motors and Generators.
   4. PS-1: Construction and Industrial Plywood.

G. National Fire Protection Association (NFPA):
   1. NFPA 13 Standard for the Installation of Sprinkler Systems
   2. NFPA 51B Standard for Fire Prevention During Welding, Cutting, and Other Hot Work
   3. NFPA 70 National Electrical Code
   4. NFPA 70E Standard for Electrical Safety in the Workplace

5. NFPA 72 National Fire Alarm and Signaling Code
6. NFPA 73 Standard for Inspections for Existing Dwellings
7. NFPA 79 Standard for Industrial Machinery
8. NFPA 80 Fire Doors and Windows
9. NFPA 101 Life Safety Code

H. Americans with Disabilities Act (ADA)
    1. Standards for Accessible Design

I. Texas Architectural Barriers Act (TABA)

J. Texas Accessibility Standards (TAS)

K. Other:
    1. MIL-L-1914: Lumber and Plywood, Fire Retardant Treated.
    2. AWS D1.1: Structural Welding Code.
    3. AISC-Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
    4. ANSI/IEEE 519: Electrical harmonic requirements.

1.8 BUILDING FEATURES

A. When required by the building code (when the elevator is not part of the accessible means of egress) the pictograph (ASME A17.1/CSA B44 Fig 2.27.9) shall be used at all landings incorporated either into the hall push button station or as a stand-alone sign above the hall push button.

B. The acoustic output of any equipment in the machine/control room/space shall not be greater than eighty (80) dBA, measured at any point within the room/space. Provide an elevator machine/control room/space with a sound transmission coefficient design that will keep audible sound to below sixty-five (65) dBA when measured anywhere outside the room/space.

C. A class “ABC” fire extinguisher shall be provided in the elevator machine/control room/space outside the hoistway. It shall be located on the strike side of the access door.

D. All machine/control rooms/spaces shall have permanent lighting; 200 lx (19 fc) measured on the floor in front of the elevator controller and the floor around the elevator machine and shall have an efficacy greater than or equal to fifty (50) lumens/watt and comply with requirements in Division 26. The lighting shall be provided with emergency power when the elevator is supplied with emergency power. The switch shall be located within twelve (12) inches of the jamb on the strike side of the door.

E. The entire height of the hoistway shall be illuminated at not less than 50 lx (5 fc) and shall have an efficacy greater than or equal to fifty (50) lumens/watt and comply with requirements in Division 26.

F. Each elevator landing shall be illuminated at not less than 100 lx (10 fc) measured at the floor in front of the closed landing door and shall have an efficacy greater than or equal to fifty (50) lumens/watt and comply with requirements in Division 26.

G. The machine/control room/space shall be provided with independent ventilation or air-conditioning system to maintain the temperature and humidity in the range specified by the equipment manufacturer during firefighters' operation. The ventilation shall be provided with emergency power when the elevator is supplied with emergency power.

H. Provide a telephone inside the elevator machine/control room/space for communication with the elevator car. The phone shall operate for a minimum of four (4) hours when normal power has been lost.

I. Where buildings are designed with expansion joints, the machine room and the hoistway shall be located on the same side of an expansion joint.

J. Only elevator equipment is allowed in an elevator machine/control room/space.

K. Per IBC 3002.9, 3005.6, IMC 303.8, 1107.2, IPC 301.6, 1003.4, and ASME A17.1/CSA B44 section 2.8 **electrical, mechanical, and plumbing systems** (except for those needed to support the elevator room and equipment) are **not** allowed inside **nor** are they **allowed to pass through** any elevator hoistway and/or machine/control room/space.

L. Pipes, conduits, or ducts conveying air, gases, vapors, or liquids, which are not used in connection with the operation of the elevator, are not permitted in the hoistway or machine/control rooms/spaces.

M. When sprinklers are required in the machine/control room/space a means to remove power to the elevator before the application of water from the sprinkler shall be provided and there shall be a smoke detector in the machine room.

N. When the hoistway is required to be sprinkled, a means to remove power to the elevator before the application of water from the sprinkler shall be provided and a smoke detector shall be installed in the hoistway.

O. When the hoistway is not required to be sprinkled there shall not be a smoke detector in the hoistway unless it is for activation of smoke control equipment.

P. A sprinkler is required in the pit of hydraulic elevators. If the sprinkler is no more than two feet from the pit floor, no heat detector is required.

Q. A sprinkler is required in the pit and the top of the shaft for elevators suspended by non-circular elastomeric coated steel belts.

R. A sprinkler is required in the elevator machine/control room/space.

S. All sprinkler risers and returns shall be located outside the hoistway and machine room. Branch lines in the hoistway shall supply sprinklers at no more than one floor level.

T. When required by the building code, elevator hoistways shall be provided with smoke ventilation:

   1. Smoke ventilation shall be provided with Class I motorized dampers with a maximum leakage rate of 4 cfm/ft² at a 1.0-inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D.
   2. Shaft vent damper shall be installed with controls so that they are capable of automatically opening upon activation of any fire alarm initiating device of the building's fire alarm system and/or the interruption of power to the damper.
   3. The smoke vent shall be installed with override switches in accordance with IBC and IFC sections 909 and 910.
   4. The smoke vent shall be properly sized to provide adequate ventilation of smoke from the hoistway. The minimum size shall be a vent that has a net area greater than or equal to 3½% of the hoistway square area or a minimum of three (3) square feet per elevator whichever is larger.
   5. It shall have a rainproof exterior vent matching the exterior finish of the building. The vent shall be installed as required by the manufacturer to prevent water from seeping or migrating through cracks into the building.

U. Machine/control room/space door shall be self-closing and self-locking. The lock shall be arranged to always be locked from the outside and always unlocked on the inside (store room function). Keys to unlock the machine/control room/space doors shall be readily accessible to authorized personnel, but not accessible to the general public (Group 2 Security as defined by ASME A17.1/CSA B44 section 8.1). Locks shall be keyed to the University standard for an elevator machine room.

V. Elevator, dumbwaiter, and other hoistways shall be constructed in accordance with the requirements of IBC section 713 and Chapter 30.

W. Hoistway walls shall be substantially flush on the hoistway side. Any offsets over four (4) inches shall be provided with a beveled angle of not less than seventy-five (75) degrees off the horizontal.

X. An approved fire stop system shall be used for all penetrations of the elevator hoistway. Any holes in the hoistway walls shall be patched and all screws or other items projecting into the elevator shaft shall be made flush with the inside hoistway walls.

Y. The space between sill and supporting steel of the hall doorsills and between the floor and sill edge shall be filled with grout. The sill shall be flush with the finished floor.

Z. Elevator landing floors shall be flush with the top of the elevator landing sill and not have any slopes or cross slopes exceeding 1:48.

AA. Machine/control rooms/spaces containing equipment, sheaves, and other machinery shall be enclosed with a fire-resistive enclosure. Enclosures and access doors shall have a fire-resistance rating at least equal to that required for the hoistway enclosure.

BB. A Fire Alarm Initiating Device (FAID) is required for emergency elevator recall in each elevator lobby. The FAID is to be placed on the ceiling within a twenty-one (21) foot radius of the center of the elevator doors. FAIDs shall not be self-resetting. The control relays from the fire alarm are to be mounted within three (3) feet of the "Demarcation" box located in the elevator machine room. In cases where there are multiple machine rooms per group of elevators, consult with UT's Utilities and Energy Management (UEM) Elevator section for details on device placement. Separate recall zones are required to provide primary (Designated landing) and alternate recall floors. Separate inputs, for activation of the flashing hat function, to the elevator controller are required for recall from hoistway and machine/control room/space FAIDs. Consult with UT's UEM Elevator section for specific requirements.

CC. If access to the pit is from the lowest landing door, a non-combustible pit ladder is to extend from the pit floor upward to a point not less than forty-eight inches (48”) above the bottom landing floor level. The ladder rungs, cleats, or steps shall be a minimum of 16" wide. The rungs of the ladder shall be provided at twelve-inch (12") intervals to a height not less than the height of the entrance doorsill. One ladder per elevator is required. Pit access by a ladder shall not be permitted when the pit floor is more than 3000 mm (120 in.) below the sill of the access door.

Exception: Where there is no building floor below the bottom terminal landing, this height shall be permitted to be greater but not more than 4200 mm (165 in.).

DD. In no case shall the available refuge space, in the pit or on top of the car, be less than either of the following:

1. a horizontal area of 600 mm x 1200 mm (24 in. x 48 in.) with a height of 600mm (24 in.)
2. a horizontal area of 450 mm x 900 mm (18 in. x 35 in.) with a height of 1070 mm (42 in.)

EE. The pit lighting shall provide not less than 100 lx (10 fc) at the pit floor and at a pit platform. A separate branch circuit for each elevator pit/hoistway shall supply the pit/hoistway lighting. The pit/hoistway lighting switch shall be accessible from the point of hoistway access at the top and bottom of the shaft. The pit lighting shall be NEMA 4 if mounted less than forty-eight inches (48”) above the pit floor measured directly below the device.

FF. The pit convenience outlet shall be a GFCI and rated as NEMA 4 if mounted less than forty-eight inches (48”) above the pit floor measured directly below the device.

GG. Elevator pits shall be designed with a permanent means to prevent the entry of groundwater and remain dry. A sump pump or drain with a capacity of 3000 gallons per hour per elevator (exceptions by the elevator, building, and plumbing codes allow this pump to be in the elevator pit) is required when an elevator is provided with Firefighter’s Phase II operation:

1. The sump pump recess must have a metal grate cover that is flush with the pit floor.
2. The sump pump shall be connected to a separate dedicated branch circuit Non-GFCI single outlet or be directly wired; connections shall be NEMA 4 if mounted below 48 inches above the pit floor.
3. The control panel for the sump pump shall be located outside of the pit and/or elevator machine/control room/space. The controls shall be configured to only pump water and not allow any oil to be pumped from the pit.
   a. This "Oil Minder" system typically uses the conductive properties of water and the insulative properties of the oil. The system usually has high water on function, low water off function, and an oil alarm float. In normal use, if any oil were to fill the sump no activation of the pump will take place. When water begins to fill the sump, the oil floats on top of the water, and only when the water reaches the on trigger does the pump activate. When the water falls to the level of the off

trigger the pump shuts down maintaining the oil inside the elevator pit.

4. The sump pump discharge pipe shall be indirectly connected to the building's plumbing system to prevent water, gasses, and odors from entering the hoistway.
5. Use a metal discharge pipe adequately sized, supported, and braced. The location of the pipe shall not interfere with the operation of the elevator. PVC IS NOT ACCEPTABLE.
6. The sump discharge shall comply with the agreements between The University of Texas at San Antonio and the local storm and sanitary sewer utility owner. These agreements are managed by UT Environmental Health & Safety.

HH. A separate branch circuit selectively coordinated for each elevator shall be provided to the mainline disconnect switch (preferably on the strike side of the access door). The switch shall be provided in the machine/control room/space and shall be readily accessible. The switch is to be lockable in the open position and have overcurrent protection. The disconnect switch must be located within the line of sight of the elevator machine and when standing in front of the elevator controller. The disconnect shall be of the type that cannot be put into the energized position with the cover open nor can the cover be opened when the switch is in the energized position.

1. If the elevator utilizes a battery-powered emergency rescue unit, the mainline disconnect shall have auxiliary contacts positively opened by the action of the switch (not relying on the action of springs) to remove power from the battery power unit.

II. Shunt trip (IBC 3005.5), if used, shall be permitted to be integrated into the disconnect switch or may be a separate enclosure in the elevator machine room or elsewhere in the building.

JJ. A separate branch circuit selectively coordinated for each elevator shall be provided to the car light disconnect switch in the machine/control room/space (preferably on the strike side of the access door). The disconnect switch shall be lockable in the open position, shall provide overcurrent protection, and shall be readily accessible. The disconnect shall be of the type that locks the door closed when in the energized position and cannot be put into the energized position with the cover open.

KK. All wiring shall be enclosed inside piping in accordance with NFPA 70 and the following:

1. Flexible conduit is only allowed on equipment that requires periodic adjustment, flexible conduit is not allowed on permanently fixed equipment;
2. Hall button wires are not to be run inside flexible conduit;
3. The length of flexible cords and conduits shall not exceed three (3) feet;
4. Flexible cords for door closing protection are allowed provided that they are protected within recesses of the car top and/or conduit from the point of attachment on the car door header to their respective control panel;
5. And Conductors in vertical raceways shall be supported at the top of the vertical sections of the raceway and at intervals not exceeding those shown in NFPA 70 table 300.19(A). Conductors in the car operating panel shall be provided with supports to keep wires from exerting pressure on the operating switches.

1.9 ESCALATOR BASIC REQUIREMENTS

A. The escalator drive system shall have a rated efficiency greater than or equal to ninety-four percent (94%) at full load. Either induction motors with a class IE3 efficiency rating, as defined by IEC EN 60034-30, or permanent magnet synchronous motors shall be used.

B. Down-running escalators shall recover potential energy released during motion and return it to the power grid.

C. The escalator shall be capable of automatically slowing and or stopping under light traffic conditions, it shall be designed using the requirements of ASME A17.1/CSA B44 section 6.1.4.1.2.

D. The escalator shall be designed for transit duty with a service life of thirty (30) years.

E. SAFETY ZONE: The entry and exit zones shall be kept clear of all obstacles. The width of the zones shall be not less than the width between the centerlines of the handrail plus 8 in. (203mm). The length of the zone, measured from the end of the newel, shall be no less than twice the distance between the centerline of the handrails. These dimensions are absolute minimums and every consideration should be given to traffic patterns.

F. The headroom shall be seven feet (7') (2.13 m) measured vertically from the step noseline, landing plates, and landings.

G. Rolling shutters, if used, shall be provided with a device that shall be actuated as the shutters begin to close to cause the electric power to be removed from the escalator driving machine motor and brake.

H. Handrails shall use friction-reducing measures, such as, but not limited to, rollers in the newels.

I. Light sources, including, but not limited to, balustrade lighting, comb plate lighting, step demarcation lighting, and general area lighting shall have an efficacy greater than or equal to fifty (50) lumens/watt and comply with requirements in Division 26.

J. The lighting of escalator landing floor plates and all exposed step treads shall be illuminated with a lighting intensity of not less than 50 lx (5 fc). The illumination of these surfaces shall be of uniform intensity and not contrast materially with that of the surrounding area.

K. The interior of the escalator truss shall have a 15 amp 120 VAC GFCI duplex receptacle in an accessible location under the access plates at the top and bottom landings, and in any machine areas located along the incline.

L. Reasonable access to the interior of the escalator shall be provided for inspection and maintenance.

M. All wiring shall be enclosed inside piping in accordance with NFPA 70. Flexible conduit is only allowed on equipment that requires periodic adjustment, it is not allowed on a permanently fixed equipment.

1.10 Dumbwaiters

A. Dumbwaiters shall be designed to have a minimum component service life of fifteen (15) years.

B. Dumbwaiters shall be powered, hand dumbwaiters are prohibited.

C. Interlocks meeting the requirements of ASME A17.1/CSA b44 section 2.12 shall protect all doors.

D. Drive machines and control equipment shall be serviceable without entering the hoistway.

1.11 Material Lifts

A. Material lifts shall be designed and manufactured to operate in the proximity of the general public.

B. Material lifts shall conform to the requirements of ASME A17.1/CSA b44 part 7.

C. Material lifts shall have a minimum component service life of thirty (30) years.

D. Interlocks meeting the requirements of ASME A17.1/CSA b44 section 2.12 shall protect all doors.

E. Material lifts shall be designed to operate within guide rails.

F. Driving machines and control equipment for material lifts shall be located in a machine room.

1.12 Platform Lifts

A. Platform lifts shall be rated as the commercial duty with a minimum component service life of fifteen (15) years.

B. The lift shall be installed on an approved runway.

C. Platform lifts shall meet the requirements of ASME A18.1 except that door interlocks meeting the requirements of ASME A17.1/CSA b44 section 2.12 shall protect all runway doors. The label on the interlock shall also include the model number and date of testing.

D. Platform lifts shall be provided with a two-way communication device.

E. Platform lifts shall be provided with emergency power.

F. Platform lifts shall be provided with a means to raise or lower the platform in the event of power failure. The means shall be accessible and operable from outside the runway.

G. The running clearance between the enclosure wall ends and the entrance and exit side of the runway shall be not less than 10mm (0.375 in) nor more than 20mm (0.75in).

H. Platform lifts shall not be attendant operated.

I. TAS section 309 prohibits lifts from having key locks to operate them. Lifts must not require the user to seek additional assistance to be able to use them. The lift shall not be used to provide security to any part of a building. It is a violation of TAS for the lift to limit accessibility, security must be provided without disabling the lift.

J. Lifts shall be provided with a pit of sufficient depth to allow the platform to be flush with the lowest landing and avoid the use of ramps (which present a tripping hazard when placed outside a runway).

K. Platform lift shall be provided with a minimum illumination of 50 lx (5 fc) at the controls, platform floor, and threshold of the floor.

L. An auxiliary illumination source to provide general illumination of not less than 2.2 lx (.2 fc) on the floor and controls shall be provided. The auxiliary system shall be automatically activated when normal power fails and shall be capable of maintaining the light intensity for a period of not less than four hours and shall use no fewer than two bulbs of approximately equal wattage.

M. The pit of the lift shall be provided with a permanent lighting fixture providing a minimum of 100 lx (10 fc) on the pit floor. The switch shall be located to be accessible from the access door.

N. A stop switch shall be provided in the pit. The switch shall be accessible from the access door.

O. The installation of electrical equipment and wiring shall conform to the requirements of NFPA 70. Electrical equipment shall be certified to the requirements of ASME A17.5.

1.13 MAINTENANCE SERVICE

A. Provide service and maintenance as described in the University of Texas maintenance specifications of elevator systems and components for 90 days from the date of final acceptance of the last unit completed. A copy of the University of Texas' maintenance specifications will be furnished upon request. Documentation shall be provided in the maintenance control program (MCP) during the included service period. It will detail the dates, times, type of maintenance that was provided, and the person performing the service.

B. The elevator contractor shall schedule, with the Project Manager, a walk-through inspection two (2) weeks prior to the expiration of the ninety (90) day service period. All deficiencies identified shall be repaired/replaced/completed prior to the end of the service contract.

C. Examine system components semi-monthly. Clean, adjust, and lubricate equipment.

D. Include systematic examination, adjustment, and lubrication of elevator equipment. Repair or replace parts when required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.
   1. Include monthly Fire Service test and emergency light tests.
   2. Detail operations performed within the MCP logbook kept in the elevator machine room.
   3. Include cleaning Hoistway sills and Car sills.
   4. Include elevator cab handrails.

E. Perform work without removing cars during peak traffic periods.

F. Maintain in San Antonio, TX an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service on a 24-hour emergency call basis for this maintenance period.

G. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the Elevator Contractor.

H. Maintenance service shall not be assigned or transferred to any agent or subcontractor without the prior written consent of the owner.

1.14 ACCEPTANCE AND COMMISSIONING

A. Elevators, escalators, material lifts, and dumbwaiters shall be inspected in conformance with these design criteria, the design specifications, the TDLR approved and permitted elevator installer drawings, the requirements of ASME A17.1/CSA b44, ASME A17.5, IBC, IPC, IMC, NFPA 101, NFPA 70, NFPA 72, NFPA 13, TAS, and any other federal, state, or local laws and/or regulations.

B. Platform lifts shall be inspected in conformance with ASME A18.1, TAS, and any other federal, state, or local laws and/or regulations.

C. A certified qualified elevator inspector (QEI) provided by the university shall inspect elevator equipment.

D. A maintenance control program (MCP) shall be provided for each piece of elevator equipment. It shall be available at the time of inspection. The MCP shall be complete and onsite before any portion of the final inspection takes place.

E. The university inspector will only perform a final acceptance inspection when all portions of the elevator systems and building support systems are complete. The university inspector will not perform inspections for construction use.

F. The university inspector shall verify the performance requirements of these criteria and the specifications during the inspection.

G. Elevator equipment will not be released for public use until all corrections have been made and the unit is operating satisfactorily.

H. The included manufacturer’s warranty period shall begin on the first day of the month following the date of final acceptance. In a building with multiple elevators, the equipment shall be grouped by machine/control room/space. The warranty period begins on the first day of the month following the acceptance of the last piece of elevator equipment in the defined machine/control room/space. (substantial partial completion acceptance of the building is not an indication of the completeness of the elevator systems.)

I. The contractor shall provide semi-monthly (two visits per month) planned maintenance services for the entirety of the warranty period in accordance with the manufacturers requirements and the MCP. All work shall be documented within the logs of the MCP.

J. The contractor shall provide 24-hour callback service seven days a week including holidays for the purpose of getting passengers out of a stalled elevator or to maintain accessibility in a building with only one elevator. All work shall be documented within the logs of the MCP.

K. The university's inspector will evaluate the condition of the elevator equipment in the tenth month of the warranty period. Any parts that are excessively worn or are in need of adjustment shall be adjusted or replaced. All corrections shall be made before the end of the eleventh month of the warranty period. All work shall be documented within the logs of the MCP.

L. The contractor shall provide an over the door lock box for securing the elevator machine room key. Lock box shall not require fasteners to be drilled into the door.

Specification	Specification Description
20 01 00 00	Basic Fire Suppression, Plumbing and HVAC Requirements
20 05 29 00	Supports and Sleeves
20 05 48 00	Vibration Isolation
20 05 53 00	Piping and Equipment Identification
20 07 00 00	Equipment Insulation
20 07 19 00	Piping Insulation
20 08 00 00	Fire Supression/Plumbing/HVAC Systems Commissioning
20 08 13 00	Fire Supression/Plumbing/HVAC systems Prefunctional Checklist and Start-Ups
20 08 16 00	Hvac/ Plumbing/Fire Supression Systems Functional Performance Tests

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SECTION 20 01 00 00 - BASIC FIRE SUPPRESSION, PLUMBING AND HVAC REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

All work covered by this section of these specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.02 SUMMARY

Basic and supplemental requirements common to Fire Suppression, Plumbing and HVAC Work.

The design guidelines contained herein include the requirements for systems, materials, fittings and valves utilized for fire protection systems at The University of Texas at Austin. It is the intention of this document to provide a minimum standard for fire protection materials, fittings, and valves at the University so as to provide the highest level of fire safety possible.

Provide all design, materials and installation required to provide a complete fire protection system to protect the specified building in accordance with design requirements.

1.03 REFERENCE STANDARDS

The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the Contract Documents.

Reference

1. ANSI-NEMA Standards: National Electrical Manufacturers Association
2. NFPA 1 – Fire Code
3. NFPA 11 - Standard for Low-, Medium-, and High-Expansion Foam
4. NFPA 13 – Installation of Sprinkler Systems.
5. NFPA 14 – Standard for the Installation of Standpipe and Hose Systems
6. NFPA 16 – Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems
7. NFPA 17 – Standard for Dry Chemical Extinguishing Systems
8. NFPA 17A – Standard for Wet Chemical Extinguishing Systems

9. NFPA 20 – Standard for the Installation for Stationary Pumps for Fire Protection.

10. NFPA 24 – Installation of Private Fire Service Mains and their Appurtenances.

11. NFPA 25 – Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems.

12. NFPA 72 – National Fire Alarm and Signaling Code.

13. NFPA 96 – Standard for Ventilation Control and Fire Protection of Chemical Cooking Operations

14. NFPA 101 – Life Safety Code

15. NFPA 2001 – Standard on Clean Agent Fire Extinguishing Systems

1.04 DEFINITIONS

These definitions are included to clarify the direction and intention of these Specifications. For further clarification,

1. Concealed / Exposed: "Concealed" areas are those areas that cannot be seen by the building occupants. "Exposed" areas are all areas, which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms. “Exterior” areas are those that are outside the building exterior envelope and exposed to the outdoors.

2. Furnish: The term "furnish" is used to mean "supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.

3. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

4. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use.

1.05 QUALITY ASSURANCE

Fire Suppression, Plumbing and HVAC systems shall be coordinated with other systems and trades to include but not be limited to: Electrical systems, fire alarm, security systems, transport systems, telephone, and data systems.

Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of Contractor’s Work to the building structure and to the Work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the Work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any Work. Adjustments to the Work required in order to facilitate a coordinated installation shall be made at no additional cost to The University or the Architect/Engineer.

All dimensional information related to new structures shall be taken from the appropriate Drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the Site.

The Drawings are subject to the requirements of Reference Standards, structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of Work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

When the Drawings do not give exact details as to the elevation of pipe and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping and duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

Where core drilling of floor or wall penetrations is required, Work shall be performed in accordance with Division 03 Specifications. Where applicable Division 03 Specifications are not included in the Project, core drilling shall be in accordance with generally accepted standards, and be performed by licensed personnel where applicable.

Certify in writing that neither the Contractor nor any of Contractor's subcontractors or suppliers will supply any materials that contain any asbestos in any form for this Project.

The International Building Code, National Fire Codes as published by the National Fire Protection Association (NFPA), and The UT Health San Antonio requirements contain fire protection criteria and requirements for the installation of all fire suppression systems. The Contractor shall conform to the following additional requirements.;

All materials and performances shall meet the appropriate ANSI, ASME and ASTM Codes.

Welding Materials and Procedures shall conform to the ASME Code.

Only welders certified in accordance with ANSI/ASME Section 9 shall be employed.

1.06 DELIVERY, STORAGE AND HANDLING

All equipment, ductwork, and materials shall be delivered to the Project Site clean and sealed for protection.

Take particular care not to damage the existing construction in performing Work. All finished floors, step treads and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the Project.

Equipment and materials shall be protected from rust and dust/debris both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.

All material affected by weather shall be covered and protected to keep the material free from damage while material is being transported to the Site and while stored at the Project Site.

During the execution of the Work, open ends of all piping and conduit, and all openings in equipment shall be closed when Work is not in progress and shall be capped and sealed prior to completion of final connections, so as to prevent the entrance of foreign matter.

All equipment shall be protected during the execution of the Work. All ductwork and equipment shall be sealed with heavy plastic and tape to prevent build-up of dust and debris.

All ductwork and air handling equipment shall be wiped down with a damp cloth immediately before installation to ensure complete removal of accumulated dusts and foreign matter.

All plumbing fixtures shall be protected and covered to prohibit usage. All drains shall be covered until placed in service to prevent the entrance of foreign matter.

1.07 SUBMITTALS

Product Data: Provide coordination Drawings with submittals as required by Division 01.

Record Documents: In addition to hard copy format, all material submitted as final record products shall be submitted to the Owner in its original electronic file format on compact disc or DVD. Approved As-Built Drawings, Valve Charts, and Shop Drawing submittals shall be provided in Auto CAD format.

Refer to provisions established in the Project Specifications and in related section of Division 01 – General Requirements. All product data shall be submitted under provisions of Division 01.

1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
2. Manufacturer's standardized schematic diagrams and data sheets shall not be acceptable unless applicable portions of it are clearly indicated and non-applicable portions clearly deleted or crossed out.
3. All electrical related schematic, connection and/or interconnection diagrams in accordance with the latest edition of NEMA (National Electrical Manufacturers Association)..
4. Provide submittals as required by individual specification Section.
5. Provide submittal with data sheets with manufacturer's name clearly indicated. Applicable portions shall be circled and non-applicable portions shall be crossed out.
6. Provide submittal with line-by-line specification review by equipment manufacturer and contractor with any exceptions explicitly defined.
7. Provide submittal with manufacturer’s data sheets shall be provided for all materials and equipment for approval before purchase or installation. Data sheets shall describe the type of material, capacities, manufacturer, part numbers of equipment, and give information necessary for verifying equipment approval.

The Contractor shall submit detailed and accurate shop drawings prepared in accordance with NFPA 13, NFPA 14, NFPA 20, and NFPA 24 and all other applicable NFPA standards for approval of all equipment to be constructed and installed. Shop drawings shall identify all materials and list all equipment to be used. Shop drawings shall include ceiling grid or reflected ceiling layout and shall be coordinated with other trades prior to submittal. Shop drawings are to be submitted with a minimum 1/8” scale and all details at a minimum ¼” scale.

No work shall be performed until the University has approved the shop drawings, calculations, and data sheets. The contractor is solely liable for any work performed prior to this approval.

1.08 WARRANTY

All fire suppression systems, components and controls shall be provided with a standard warranty (refer to Division 1: Warranties) that shall initiate upon substantial completion of the building.

All fire suppression systems, components and controls shall be provided with a standard warranty (refer to Division 1: Warranties) that shall initiate upon substantial completion of the building.

PART 2 - PRODUCTS

2.01 GENERAL

All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.

Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.

Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with Contract Documents.

Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

Where make and model listed, contractor may provide owner approved equal. Substitutions must be provided in accordance with General Conditions.

All pipe, fittings, couplings, gaskets and valves shall be manufactured domestically.

2.02 NAMEPLATES

Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16-inch-high engraved white letters.

Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.

Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.

1. Individual Starters, Contactors, Disconnect Switches, VFDs, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

2.03 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes, ducts, conduits, etc., passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.

Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.

For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.

Plates will not be required for piping where pipe sleeves extend ¾-inch or more above finished floor.

Round and rectangular ducts shall have closure plates (not chrome plated) made to fit accurately at all floor, wall and ceiling penetrations.

2.04 ROOF PENETRATIONS AND FLASHING

Pipe, conduit and duct sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such Work. Installation shall comply with the Contract Documents and with FM General Data Sheets 1-28, 1-29, 1-31 & 1-49 along with the FM approval guide.

PART 3 - EXECUTION

3.01 PREPARATION

Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.

The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

Space Requirements:

Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.

Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to The University.

Connections for equipment other than Divisions 21, 22, 23:

1. Rough-in and provide all gas, air, water, steam, sewer, etc. connections to all fixtures, equipment, machinery, etc., furnished by The University and/or other trades in accordance with detailed rough-in Drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

2. After the equipment is set in place, make all final connections and provide all required pipe, fittings, valves, traps, etc.
3. Provide all backflow preventers and air gap fittings required, using approved devices. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.
4. Provide all ductwork, transition pieces, etc., required for a complete installation of vent hoods, fume hoods, etc.

3.02 INSTALLATION

Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

All installation shall be in accordance with manufacturer’s published recommendations.

Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.

All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Owner’s Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to The University at least five (5) calendar days prior to the inspection.

Precedence of Materials:

1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.
2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":
   a. Building lines
   b. Structural members
   c. Structural support frames supporting ceiling equipment
   d. Electric tracked vehicle system
   e. Pneumatic trash and linen system
   f. Pneumatic tube system
   g. Soil and drain piping
   h. Vent piping
   i. Supply, return and outside air ductwork

j. Exhaust ductwork

k. HVAC water and steam piping

l. Condensate piping

m. Fire protection piping

n. Natural gas piping

o. Medical/Laboratory gases

p. Domestic water (cold and hot, softened, treated)

q. Refrigerant piping

r. Electrical conduit

3. Coordinate fire suppression, plumbing and HVAC systems with transport systems as required to maintain transport system right-of-way.

3.03 TESTING

When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has The University's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of The University, or date of Substantial Completion, whichever occurs first.

Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by The University. The date of acceptance and performance certification will be the same date.

Before the Work is accepted, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of manufacturer's materials and/or equipment to determine that materials and/or equipment are properly installed and in proper operating order. The qualifications of the manufacturer's representative shall be appropriate to the technical requirements of the installation. The qualifications of the manufacturer's representative shall be submitted to The University for approval. The decision of The University concerning the appropriateness of the manufacturer's representative shall be final. Testing and checking shall be accomplished during the course of the Work where required by Work being concealed, and at the completion of the Work. In addition, the Contractor shall submit to the Architect/Engineer a signed statement from each manufacturer's representative certifying as follows: **"I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations."**

Check inspections shall include piping, equipment, heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.

The Contractor shall execute, at no additional cost to The University, any tests required by The University or the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The University will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by The University, will be borne by The University.

Notify The University's Project Manager and the Architect/Engineer in writing at least seven (7) calendar days prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.

All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results an other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.

Refer to Commissioning Specification Sections for additional Start-up, prefunctional and operational checkout, and for functional performance test procedures.

3.04 TRAINING

Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled “Project Closeout Procedures.”

Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

All equipment, piping, conduit, ductwork, grilles, insulation, etc., furnished and installed in exposed areas shall be cleaned, prepared and painted as specified in Division 09.

END OF SECTION 20 01 00 00

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SECTION 20 05 16 00 - PIPING EXPANSION COMPENSATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and division 01 specification sections, apply to this section.

B. Specifications throughout all divisions of the project manual are directly applicable to this section, and this section is directly applicable to them.

1.02 SUMMARY

A. Perform all work required to provide and install the following piping expansion compensation equipment indicated by the contract documents with supplementary items necessary for their proper installation.

1. Flexible pipe connectors.
2. Expansion joints and compensators.
3. Pipe loops, offsets, and swing joints.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this contract shall be applicable to this project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. Mil-e-17814e-expansion joints, pipe, slip-type, packed.

1.04 QUALITY ASSURANCE

A. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.

B. EXPANSION CALCULATIONS

1. Installation temperature: 50 degrees f.
2. Safety factor: 30 percent.
3. Hot water heating, domestic hot water, chilled water and steam temperature shall be as per system design.

1.05 SUBMITTALS

A. Flexible pipe connectors: indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

B. Expansion joints: indicate maximum temperature and pressure rating, and maximum expansion compensation. Indicate alignment, guide locations, quantities, spacing, etc.

C. Operation and maintenance data: include adjustment instructions, warranty.

D. Manufacturer qualifications: company specializing in manufacturing the products specified in this section with minimum three (3) years documented experience.

1.06 EXTRA MATERIALS

A. Provide two (2) 12-ounce containers of packing coverage for leak-free performance of expansion joints.

1.07 WARRANTY

A. Provide a five (5) year warranty including coverage for leak-free performance of expansion joints.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Flexible pipe connectors:

1. Hyspan model series 3505.
2. Pathway model xpress ff with anchor foot.

B. Expansion joints – steam:

1. Hyspan model series 3505.
2. Pathway model xpress ff with anchor foot.

C. Expansion joints – steel piping:

1. Hyspan model 3501 series.
2. Pathway model xpress ff with anchor foot.

D. Expansion joints – external ring:

1. Hyspan model series 5500.
2. Pathway model flexway ct.
3. Flexonics model tcs-r.

E. Pipe alignment guides:

1. Anvil model fig. 255.
2. Piping technology & products model fig. 6.

3. Hyspan model series 9500.
4. Aaa technology model fig. 295.

2.03 FLEXIBLE PIPE CONNECTORS

A. Copper piping - domestic water:
    1. Pathway model xpress ff with anchor foot.
    2. Exterior sleeve: braided bronze or stainless.
    3. Pressure rating: 200 psig wog and 250 degrees f.
    4. Joint: as specified for pipe joints.
    5. Size: use pipe-sized units.
    6. Maximum offset: 3/4 inch on each side of installed centerline.

2.04 EXPANSION JOINTS

A. Steam - stainless steel bellows (externally pressurized guided type):
    1. Pressure rating: 300 psig, maximum temperature 850 degrees f.
    2. Maximum compression: 4 inch.
    3. Maximum extension: 1 inch.
    4. Joint: as specified for ansi class.
    5. Size: use pipe-sized units.
    6. Application: steel piping 3 inches and under.

B. Steel piping - 150 psig chilled water, 150 psig heating water, and steam condensate:
    1. Annular corrugated inner core: steel laminated bellows meeting astm a 240.
    2. Exterior sleeve: steel housing meeting astm a 53 grb.
    3. Pressure rating: 150 psig and 300 psig at 750 degrees f. Refer to drawings.
    4. Joint: flanged 150 and 300 raised face as required for piping system.
    5. Size: use pipe-sized units.
    6. Axial compression: 4 inches.

C. External ring stainless steel bellows restrained (chilled and heating water pump connectors) type:
    1. Pressure rating: 350 psig at 400 degrees f.
    2. Maximum compression: 0.75 to 1.00 inches.
    3. Maximum extension: 0.25 inches.
    4. Maximum offset: 0.13 inches.
    5. Joint: flanged as required by ansi class.

6. Size: use pipe-sized units.
7. Bellows: type 321 stainless steel.
8. Application: steel piping over 3 inches.

2.05 ACCESSORIES

A. Pipe alignment guides:

1. Two (2) piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.
2. Provide and install alignment guides at expansion joints per manufacturer's requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

1. Accomplish structural work and provide equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints, and provide corrugated bellows type expansion joints where indicated on drawings or required.
2. Provide pipe anchors as shown on the drawings and/or as required to facilitate proper operation of pipe guides. Install anchors in compression. Weld anchors to pipe and to building structure
3. Provide pipe guides so that movement takes place along axis of pipe only. Guide sizes shall be the nominal pipe size with insulation. Guides shall not carry dead weight load on pipe and are not intended to take the place of the required pipe supports and rollers.
4. Construct spool pieces to exact size of flexible connection for future insertion.
5. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
6. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor the other end. Install in a horizontal plane unless indicated otherwise.
7. Rigidly anchor pipe to building structure where shown or where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

3.02 TESTING

A. Prepare and start-up systems under provisions of section 20 01 00 and section 26 01 00.

B. Provide inspection services by flexible pipe manufacturer's representative for final installation.

C. Certify that installation is in accordance with manufacturer's recommendations and that connectors are performing satisfactorily. Notify owner’s project manager at least five (5) calendar days prior to the inspection.

END OF SECTION 20 05 16 00

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SECTION 20 05 29 00 – SUPPORTS AND SLEEVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install supports, hangers, anchors, sleeves and bases for all pipe, equipment, system components and accessories, indicated by the Contract Documents with all supplementary items necessary for complete, code compliant and approved installation

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. International Mechanical Code.
2. International Plumbing Code.
3. International Fuel Gas Code.
4. ASME B31.9 - Building Services Piping.
5. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
6. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
7. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
8. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
9. MSS SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.
10. NFPA 1 – Fire Code
11. NFPA 13 – Standard for the Installation of Sprinkler Systems
12. NFPA 14 – Standard for the Installation of Standpipe and Hose Systems
13. NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection
14. NFPA 99 - Standard for Health Care Facilities.

15. UL 203 - Pipe Hanger Equipment for Fire Protection Service.
16. Underwriters Laboratories Standards and Listings.

1.04 QUALITY ASSURANCE

A. Materials and application of pipe hangers and supports shall be in accordance with MSS-SP-58 and SP-69 unless noted otherwise.

B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.

C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and sleeves. All structural hanging materials shall have a minimum safety factor of five.

D. Installer Qualifications: Utilize an installer experienced in performing Work of this Section who is experienced in installation of Work similar to that required for this Project and per the minimum requirements of MSS SP-89. Field welding of supports shall be by certified welders qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX using welding procedures per the minimum requirements of MSS SP-58.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer’s catalog data including code compliance, load capacity, and intended application.

B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

C. Shop Drawings: Submit detailed Drawings of all shop or field fabricated supports, anchors and sleeves, signed and sealed by a qualified State of Texas registered professional engineer. Indicate size and characteristics of components and fabrication details and all loads exceeding 250 pounds imposed on the base building structure.

1.06 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer’s ordering instructions and lead time requirements to avoid construction delays.

B. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact. Maintain in place until installation.

C. Store materials protected from exposure to harmful weather conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Hangers and Supports:

1. Anvil International.
2. Eaton (B-Line Series)
3. Pentair (Caddy)

4. Unistrut.

2.02 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. The design, selection, spacing, and application of horizontal and vertical pipe hangers, supports, restraints, anchors, and guides shall be as a minimum in accordance with the NFPA 13 and NFPA 14, unless otherwise indicate herein, where the more stringent requirements shall be followed.

C. Hangers shall be UL listed and/or FM Approved.

D. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.

E. All auxiliary steel required for supports, anchors, guides, etc. shall be provided.

F. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.

G. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

H. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.

I. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

J. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.

K. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

L. Hangers supporting and contacting piping shall be adjustable clevis hangers or adjustable swivel ring hangers.

   1. Clevis hangers shall be of carbon steel construction, conforming to ANSI/MSS SP-69 and MSS SP-58 (Type 1), with a nut above and below the hanger. Manufactured by Anvil Fig. 260 or approved equal.

   2. Adjustable swivel ring hangers shall be of carbon steel construction, conforming to ANSI/MSS SP-58. Strap shall be of pre-galvanized zinc material and the nut shall be zinc plated. Manufactured by Anvil Fig. 69 or approved equal.

M. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.

N. Supports for vertical piping in concealed areas shall be carbon steel double bolt riser clamps, conforming to ANSI/MSS SP-69 and MSS SP-58 (Type 8). Manufactured by Anvil Fig. 261, or other approved equal. Install riser clamp with each end having equal bearing on the building structure, and located at each floor.

O. Two-hole rigid pipe clamps at 4 ft. o.c. or steel framing channels and Anvil Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction.

P. Supports for vertical piping in exposed areas shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The contractor shall use a drilled anchor as specified above, and use an Anvil No. 595 Socket Clamp with Anvil No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.

Q. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method.

R. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

S. Vibration Isolation: Resilient hangers shall be provided on all piping connected to rotating equipment (pumps, etc.). Piping that may vibrate and create an audible noise shall also be isolated. Spring hangers or supports shall be provided where indicated on the Drawings and/or specified under Section 20 05 48.

T. Attachment:

1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

2. Inserts shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.

3. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc. All piping shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

4. Hangers shall be attached to the structure as follows:

    a. Poured In Place Concrete: Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc. spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.

b. Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.

c. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.

d. Wood Framing: Where pipes and loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.

e. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15" of each stem and in the "shadow" of the stem on the top side of the "double tees.”

f. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.

g. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.

h. Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.

U. Trapezes: . Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

V. Finishes: All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, and brackets, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. Universal concrete inserts shall be cadmium plated.

W. Provide hangers fabricated to allow vertical adjustment of 1-1/2” minimum after installation while still supporting the load. The use of pipe hooks, chains or perforated iron piping for support is prohibited.

X. Miscellaneous: Provide any other special foundations, hangers and supports indicated on the Drawings, specified elsewhere herein; or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Architect/Engineer.

2.03 ACCESSORIES

A. Hanger Rods: Galvanized mild steel threaded both ends, galvanized threaded one end, or galvanized continuous threaded.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

2.04 FLASHING AND EQUIPMENT CURBS

A. Metal Flashing: 26 gauge galvanized (stainless steel) steel.

B. Metal Counterflashing: 22 gauge galvanized (stainless steel) steel.

C. Roofing Flashing: See specifications for Roofing, elsewhere in these Specifications.

D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

E. Curbs: Welded 18 gauge galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, factory installed wood nailer.

2.05 CONCRETE FOUNDATIONS ("HOUSEKEEPING PADS")

A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, etc., shall extend 6” on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall have a ½” chamfer on all exposed edges, placed and finished smooth and level to ensure proper and continuous support for the bearing surfaces of equipment. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

2.06 WALL, FLOOR AND CEILING PLATES

A. Except as otherwise noted, provide one-piece or split hinge stainless steel escutcheons for piping around all pipes passing through walls, floors, or ceilings, in any spaces in finished areas. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

2.07 SLEEVES

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping and conduits shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.

1. Sleeve material for floors, exterior walls and load bearing walls shall be Schedule 40 galvanized steel with welded water stop rings.

2. Sleeves through interior walls and non-load bearing walls shall be galvanized sheetmetal with gauge as required by wall fire rating, 20 gauge minimum.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a modular elastomer sealing system (GPT Link-seal closure) where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe. All penetrations shall be of ample size to accommodate the pipe plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled with UL listed sealant to equal or exceed to fire rating of construction penetrated.

C. Floor sleeves shall extend above the finished floor as detailed on the drawings, except that floor sleeves in stairwells shall be flush with the finished floor. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project drawings. Where the details differ from these specifications, the drawings take precedence.

D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked watertight and airtight with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

E. Vermin proofing: The open space around all, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.

F. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.

G. Air Plenums: The space around piping, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

H. Sleeves shall not be installed in structural members unless specifically approved by the Owner.

I. Fireproofing: Seal all, pipe, conduit, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin tight barrier that is capable of containing smoke and fire up to 2000° F for two hours. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed. For wet locations, the foam material shall be a silicone RTV foam or an approved equal. For dry locations, a premixed putty equal to Nelson Flameseal Firestop putty may be used.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.02 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.03 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each change of direction and provide hangers on both sides of line valves.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support vertical piping at every floor. Provide vertical piping support at each floor with 2-bolt riser clamps. For pipe risers exceeding three floors, evaluate pipe supports for longitudinal expansion and support requirements. Support riser piping independently of horizontal piping.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Support riser piping independently of connected horizontal piping.

H. Design hangers for pipe movement without disengagement of supported pipe.

I. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed, but shall be corrosion protected with galvanized plating. Repair any damaged galvanized plating with a coating of 'Galvalum'.

J. All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the contractor shall take appropriate measures to protect the pipe or other materials from damage.)

3.04 FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrate weather or waterproofed walls, floors, and roofs.

B. Refer to Architectural drawings for detail of pipe penetrations through a roof.

C. Provide acoustical lead flashing around pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.05 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors (except in stairwells) two inches above finished floor level. Sleeves through floors shall have welded waterstop rings. Sleeves shall be sealed watertight to floors and pipe.

D. Where piping or conduit penetrates floor, ceiling, or wall, close space between pipe and adjacent work with UL listed fire stopping insulation and caulk airtight. Provide close fitting escutcheon covers, as appropriate, at both sides of penetration.

3.06 PIPE SUPPORT

A. Pipe hanger spacing and hanger rod diameter sizes shall comply with the requirements of NFPA 13.

END OF SECTION 20 05 29 00

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SECTION 20 05 48 00 - VIBRATION ISOLATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install inertia bases and vibration isolation indicated by the Contract Documents with supplementary items necessary for their proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASHRAE - Guide to Average Noise Criteria Curves.

1.04 QUALITY ASSURANCE

A. Provide for vibration isolation supports for all equipment, piping and ductwork indicated herein. The transmission of perceptible vibration, structural borne noise or objectionable air borne noise to occupied areas by equipment installed under this Contract will not be permitted. Install vibration isolators as specified herein or shown on the Drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas.

B. The vibration isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria; and one that can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

C. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

D. Provide vibration isolation devices, from a single manufacturer or supplier who will be responsible for complete coordination of all phases of this Work.

1.05 SUBMITTALS

A. Product Data:

1. Submit Shop Drawings, installation instructions, and product data.

2. Indicate vibration isolator locations, with static and dynamic load on each, on Shop Drawings and described on product data.

3. Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type and deflection of each isolator; and the supported weight, disturbing frequency and efficiency of each isolator proposed; and any calculations and other information as may be required for the Architect/Engineer to check the isolator selection for compliance with the specification.

B. Record Documents:

1. Indicate inertia bases on Shop Drawings, including dimensions.

2. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall clearly indicate outlined procedures for installing and adjusting the isolators and bases mentioned above.

3. Submittals on riser isolation system shall show initial and final loads on the structure at each support point, initial and final deflection of each isolator, amount and direction of each deflection change, total expansion and contraction of each riser and operating temperature of 180 degrees F in the riser.

4. Riser diagrams shall be prepared by the vibration isolation manufacturer and submitted for approval. These diagrams shall show initial and final spring deflections, amount and direction of deflection changes, overall expansion and contraction of the riser, and operating temperature of the medium.

5. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the design proposed when installed in accordance with submittal and these Specifications.

C. Operation and Maintenance Data:

1. Provide manufacturer’s recommended maintenance procedures.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All vibration isolators and bases shall be designed for and treated for resistance to corrosion.

C. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cadmium plated.

D. All isolators exposed to the weather shall have steel parts hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.

E. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these Specifications, but in no case shall be less than one inch. Springs shall be capable of 30 percent over-travel before becoming solid.

F. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2 inches under the isolated structure and designed so that the isolators can be installed and removed when the operating clearance is 2 inches or less. When used with spring isolators having a deflection of 2-1/2 inches or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

G. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1 inch to 2 inches.

H. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

I. Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 pounds per square foot applied to any exposed surface of the equipment without failure.

2.02 MANUFACTURERS

A. Amber Booth.

B. Korfund Dynamics.

C. Consolidated Kinetics.

D. Mason Industries.

2.03 ISOLATION BASES

A. Type SFB: A structural steel fan and motor base with NEMA standard motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive.

B. Type CPF: Concrete inertia base, consisting of full depth perimeter steel pouring form, 3000 psi concrete reinforcing bars welded in place, bolting templates with anchor bolts and height-saving brackets for side mounting of the isolators. The base shall be sized with a minimum overlap of 4 inches around the base of the equipment. Fan bases are to be supplied with NEMA standard motor slide rails.

C. The bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.

D. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

2.04 ISOLATOR TYPES

A. Isolator types and required deflections are specified under "Application." Isolator type designations are Amber Booth designators. The isolators shall comply with the following descriptions for each type required on the Project:

1. Type XL: Aluminum-housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Steel or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of ¼ inch shall be bonded to the baseplate.

2. Type SW: Adjustable, freestanding, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring mounting to baseplate and compression plate must be rigid. The neoprene pad with a minimum thickness of ¼ inch is bonded to the baseplate. A minimum horizontal-to-vertical spring rate of 1.0 is required.

3. Type BS: Spring hanger consisting of a rectangular steel box, coil spring, spring retainers, neoprene-impregnated fabric washer and steel washer.

4. Type BSA: Spring hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, coil spring, spring retainers, neoprene impregnated fabric washer and steel washer. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.

5. Type BSR: Combination spring and rubber hanger consisting of a rectangular steel box, coil spring, spring retainers and elastomeric mounting designed for ½ inch deflection.

6. Type BSRA: Combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, coil spring, spring retainers and elastomeric element. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.

7. Type RSW: Adjustable spring isolator as describe for Type SW with the addition of a fabricated steel housing suitable for recessing into a concrete inertia block. The housing has a side access.

8. Type PBS: Spring hanger as described for Type BS with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation.

9. Type PBSA: Spring hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation, and to permit transferring the load to the spring after installation, a coil spring, spring retainers, neoprene impregnated fabric washer and steel washer. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.

10. PBSR: Combination spring and elastomeric hanger as described for Type BSR with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation.

11. Type PBSRA: Combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation, a coil spring, spring retainers and elastomeric element. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.

12. Type CT: Adjustable, open-spring isolator having one or more coil springs attached to a top compression plate and a base plate. A neoprene pad with a minimum thickness of ¼ inch is bonded to the base plate. The spring assembly must fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. The isolator includes restraining bolts for connecting the top plate and lower housing to prevent the isolated equipment from rising when drained of water.

13. Type SP-NRE: Pad-type mounting consisting of two layers of 3/8 inch thick ribbed or waffled neoprene pads bonded to a 16 gauge galvanized steel separator plate. Size pads for approximately 20 to 40 psi load and a deflection of 0.12 to 0.16 inch.

14. Type BRD: Elastomeric hanger consisting of a rectangular steel box and an elastomeric isolation element of neoprene. A high-quality synthetic rubber may be used if it contains antiozone and antioxidant additives. The elements are designed for approximately ½ inch deflection and loaded so that the deflection does not exceed 15 percent of the free height of the element.

15. Type TRK: For static pressure of 3 inch water or greater, provide a set of spring-loaded thrust resistors (two or more) installed across the flexible duct connection on the fan discharge, designed to limit the movement of the fan. Coil spring static deflection capabilities of thrust resistors shall equal those of the isolators supporting the equipment up to a maximum of 2 inches.

16. Type RVD: An elastomeric mounting having a steel baseplate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric material. Mountings shall be designed for approximately ½ inch deflection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Install motor driven equipment with vibration isolators.

D. Set steel bases for one-inch clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch clearance. Adjust equipment level.

E. Isolate pumped water-piping systems with spring-type vibration isolators to produce a floating mechanical system. Provide spring isolators on piping connected to isolated equipment as follows: Static deflection for the two supports closest to equipment on each pipe connected to the equipment shall be equal to the deflection of isolated equipment. All other supports for horizontal piping shall have a minimum operating deflection of ¾ inch with a capability of an additional 50 percent travel to solid.

F. All open-type spring isolators shall be restrained as recommended by the manufacturer.

G. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, shall be mounted on the scheduled vibration isolator type to prevent transmission of vibration and noise to the building structure.

2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.

3. After piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. Isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length that will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load. All springs supporting piping that is connected to a piece of isolated equipment shall be sized for static deflection equal to that of the isolated equipment.

H. Piping (Including Generator Piping):

1. Floor mounted supports shall have the same type of isolator or media as is used for the nearest isolated equipment connected to the piping.

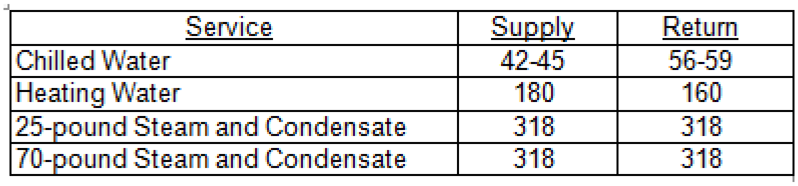
2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights and the shim blocks removed.

3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.

4. All springs supporting piping shall be capable of an additional ½ inch deflection prior to complete compression and springs supporting vertical risers shall have provisions for limit stops.

5. Support risers up through 16 inches at every third floor, and risers 18 inches and over at every second floor. All supports for risers must have a deflection capability at least four times the anticipated expansion and contraction. Install temporary anchors as required to permit preadjustment of springs in the risers. Furnish permanent limit stops to prevent excessive vertical motion of risers in the event risers are drained. Wall sleeves for takeoffs from risers shall be sized for insulation outside diameter plus two times the calculated thermal movement to prevent binding.

6. System operating temperatures (degrees F) are as follows:



Service	Supply	Return
Chilled Water	42-45	56-59
Heating Water	180	160
25-pound Steam and Condensate	318	318
70-pound Steam and Condensate	318	318

I. Resilient Sleeves: Resilient sleeves shall be provided at all points where equipment room walls, floors or ceilings are penetrated by ducts, piping or refrigerant line, etc.

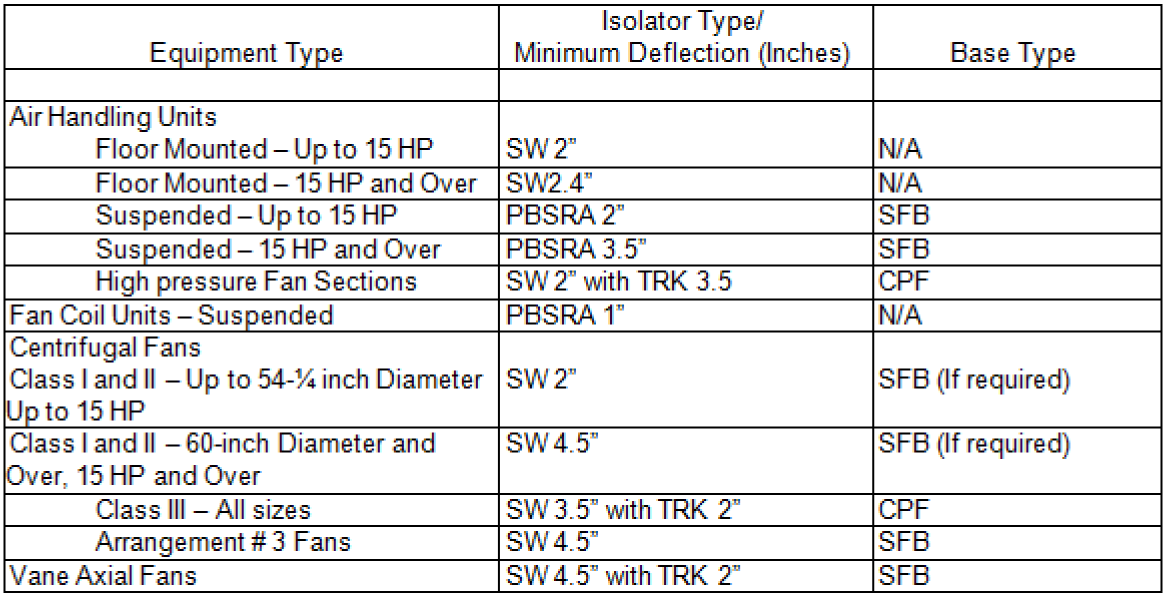
J. Fans and Air Handling Units: Such units shall have electrical flexible connections not less than 36 inches long and the flexible duct connections with a free length of not less than 8 inches.

K. Ductwork: Isolate all high pressure ductwork within each equipment room and to a minimum of 50 feet from fan with Type BS hangers or Type SW floor supports, sized for ¾ inch deflection.

L. To prevent excessive transfer of piping load from floor to floor, all water riser support springs shall have a deflection capability of four times the expansion or contraction to be accommodated by the support with the additional runout capability to absorb the movement. Isolators supporting steam and diesel engine exhaust risers shall be selected for deflections equal to two times the anticipated thermal movement at the support point. Riser isolation system shall be designed such that it supports the riser in tension, eliminating the need for guides; requires no anchors; and has a zero movement point at or near the center to divide thermal movement approximately in half, thus reducing vertical movement of horizontal pipe takeoffs.

3.02 APPLICATION

A. The following is a schedule of equipment on a typical project that requires vibration isolation and base isolators of the types specified. Refer to Drawings for equipment scheduled for the Project. Any equipment, system or condition that may be altered, added, or changed; or that is not specifically described in the Contract Documents shall be isolated in a manner specified for similar equipment, system or condition in order to comply with these Specifications.



Equipment Type	Isolator Type/ Minimum Deflection (Inches)	Base Type
Air Handling Units Floor Mounted – Up to 15 HP	SW 2”	N/A
Floor Mounted – 15 HP and Over	SW2.4”	N/A
Suspended – Up to 15 HP	PBSRA 2”	SFB
Suspended – 15 HP and Over	PBSRA 3.5”	SFB
High pressure Fan Sections	SW 2” with TRK 3.5	CPF
Fan Coil Units – Suspended	PBSRA 1”	N/A
Centrifugal Fans Class I and II – Up to 54-¼ inch Diameter Up to 15 HP	SW 2”	SFB (If required)
Class I and II – 60-inch Diameter and Over, 15 HP and Over	SW 4.5”	SFB (If required)
Class III – All sizes	SW 3.5” with TRK 2”	CPF
Arrangement # 3 Fans	SW 4.5”	SFB
Vane Axial Fans	SW 4.5” with TRK 2”	SFB

B. Piping Application:

1. Type PBSRA for hangers in all horizontal piping at equipment; except at connections to risers use BS.
2. Type SW for all floor supports of floor supported piping at equipment or stanchion.

END OF SECTION 20 05 48 00

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SECTION 20 05 53 00 - PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install nameplates, tags, stencils, and pipe markers indicated by the Contract Documents with supplementary items necessary for proper installation.

B. Contractor shall make it possible for personnel operating and maintaining the equipment and systems in this Project to readily identify the various pieces of equipment, valves, piping, ductwork, etc., by marking them.

C. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The marked item of equipment shall correspond to the same number as shown on the Drawings.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.
2. NFPA 99 – Standard for Health Care Facilities.
3. NFPA 14 – Installation of standpipe and Hose Systems.
4. NFPA 1 – Fire Code.
5. NFPA 13 – Standard for the Installation of Sprinkler Systems.
6. NFPA 14 – Standard for the Installation of Standpipe and Hose Systems.
7. NFPA 24 – Installation of Private Fire Service Mains and their Appurtenances.
8. NFPA 25 – Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems.
9. NFPA 72 – National Fire Alarm and Signaling Code.

1.04 SUBMITTALS

A. Refer to Specification Section 21 00 00 for submittal information.

B. Product Data:

1. Provide manufacturer’s catalog literature for each product.

C. Record Documents:

1. Submit valve schedule complete with asset number, building number, room number, valve tag number system, valve function, valve type, area served, year installed, manufacturer, model number, size, rated pressure, temperature rating and normal position. ProvideOwner with electronic version (Microsoft Excel) of the final approved valve schedule at or before Project Closeout.

2. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

D. Operation and Maintenance Data:

1. Manufacturer’s Installation Instructions: Indicate special procedures and installation.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Nameplates, Tags, Markers, and Tacks:

1. Marking Systems, Inc.
2. Seton Name Plate Company.
3. W.H. Brady Company.
4. Graphic Products, Inc.

2.03 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.

B. General:

1. All items of mechanical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16 inch thick, 3-ply, with black surfaces and white core using an approved plastic laminate glue. Engraving shall be condensed Gothic, at least ½ inch high, appropriately spaced.

2. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served and other pertinent information.

3. Motor nameplate information shall include manufacturer, horsepower, amperage, voltage, rpm and service factor.

4. All fans shall have manufacturer’s name, flow (cfm) and static pressure, and pumps shall have manufacturer’s name, flow (gpm), head (feet TDH) and impeller diameter.

5. All scheduled equipment shall be labeled. Associated VFD’s & disconnects shall be labeled as well.

2.04 EQUIPMENT IDENTIFICATION

A. Equipment shall be identified by the attachment of engraved nameplates.

B. The nameplates shall be constructed from laminated phenolic plastic, at least 1/16" thick, 3ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

1. Pumps
2. Storage Tanks
3. Air Compressors
4. Pre-Action and Dry Pipe Valves
5. Control Panels and Switches
6. Miscellaneous similar and/or related items

C. Small devices, such as small pre-action or dry pipe valves, air compressors, etc. may be identified with tags.

2.05 VALVE TAGS

A. All control, drain, venting, and test connection valves shall be identified.

B. Valve identification signs shall be weatherproof metal or rigid plastic and be permanently marked. Each sign shall be attached to its valve with copper clad annealed iron wire, corrosion resistant chain or other approved material.

C. The signs shall indicate what the valve is controlling and if it is normally open or normally closed and if it is used for bypass purposes.

D. Signs on control valves shall identify the portion of the building served.

E. Systems that have more than one control valve that must be closed to work on a system or space shall have a sign referring to the existence and location of other valves.

F. Valves associated with PRV station assemblies, backflow preventers, etc. shall also be identified.

G. Valves that are located in concealed spaces (such as above ceiling or behind access panels) shall also be provided with signs that are visible from outside of the concealed space that identify the nature and location of the concealed equipment.

H. Valve tags shall conform to ANSI/ASME A13.1-2007 "Scheme for the Identification of Piping Systems", refer to UT Health master detail P-01 for abbreviation and label color designations.

I. ABS Plastic Tags: Injected molded ABS plastic, 3.375” X 4.75” with self-adhesive vinyl label, similar to DuraLabel Pro, affixed to valve tag.

J. Vinyl Label: 3.0 Mil self-adhesive vinyl similar to Dura Label Pro. Label color shall be as per the standard designated colors listed in the attachment to this specification. The label shall contain the following information as per template, refer to Attachment “A”:

K. Valve name: refer to Attachment “D” for valve tag naming convention

L. Function

M. Area served

N. Asset number

O. Asset number bar code

P. Valve Tag Fasteners: Single ABS plastic tie strap

Q. Each valve shall be named as per attached valve tag naming convention, refer to Attachment “D”.

2.06 PIPE AND DUCT MARKERS

A. Round Pipe and Duct Markers shall conform to ANSI A13.1-2007 "Scheme for the Identification of Piping Systems", refer to UT Health master detail P-01 for abbreviation and label color designations. Arrow markers must have same ANSI background colors as their companion pipe markers or be incorporated into the pipe identification marker.

B. Rectangular Duct Stencils shall conform to ANSI A13.1-2007 "Scheme for the Identification of Piping Systems", refer to UT Health master detail P-01 for abbreviation and label color designations. Letter height shall be a minimum of 1-1/4”. Stencil material shall be fiber board; Stencil paint shall be exterior, gloss, acrylic enamel. The following rectangular duct systems shall be stenciled:

1. Chemical Fume Hood Exhaust.
2. Biosafety Cabinet Exhaust.
3. Radioisotope Exhaust.
4. ETO Exhaust.
5. Hot & cold deck ducts in chases.

C. Color: Conform to ASME A13.1.

D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed. Verify with Drawings for all HVAC and plumbing systems for sizes.

E. Plastic Tape Pipe Markers: Heat sealed or heat shrink, spring fasteners, clips or snap-on, are acceptable.

F. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

G. All medical gas piping shall have minimum information per NFPA 99, plus operating pressure.

H. Pipe markers and arrow markers also shall be provided for all piping systems.

I. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, ¾ inch through 6 inch. For piping systems larger than 6 inches, use Seton or Brady strap-on markers or similar by Marking Services, Inc.

2.07 LOCATER TACKS FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

A. Description: Steel with ¾-inch diameter color-coded head.

B. Color code as follows:

1. Yellow - HVAC equipment fan-coil units, exhaust fans and terminal units.
2. Red - Fire dampers/smoke dampers.
3. Green - Plumbing valves, medical gas/vacuum valves.
4. Blue - Heating/cooling valves.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

D. Identify all control valves, including drain valves, to indicate their function and what they control, per NFPA 13.Install tags with corrosion resistant chain.

E. Install plastic tape, and pipe markers completely around pipe in accordance with manufacturer's instructions.

F. Tag automatic controls, instruments, and relays. Key to control schematic.

G. Provide ceiling tacks to locate valves or other concealed equipment above Tbar type panel ceilings. Locate in corner of panel closest to equipment.

H. Arrow markers must have same ANSI background colors as their companion pipe markers or be incorporated into the pipe identification marker.

I. Provide riser general information signage per section 25.6 of NFPA 13.

J. Provide riser hydraulic information signage per section 25.5 of NFPA 13.

K. Provide FDC information signage per State Fire Marshal directive and verbiage requirement.

3.03 VALVE TAGS

A. Contractor(s) shall provide and install valve tags on all valves installed within this Project, except check valves; valves within fabricated equipment units; faucets; hose connections; needle valves; gauge cocks; HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

B. Existing valve tags shall not be attached to new valves. When removing and/or replacing existing tagged valves, give The University all existing tags that are attached to the valves that are removed. New tags with new asset numbers shall be provided for new valves.

C. Tags shall be 1/8 inch thick injected molded ABS plastic, 3.375" X 4.75" with self adhesive vinyl label on each side of tag. Each tag shall be attached to its valve with one tie strap.

D. In addition to valve tags, valves at water headers and steam PRV stations, valves associated with condensate, gas, water meters and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2-½ inches wide by 1-½ inches high with these color codings:

1. Red = normally closed.
2. Green = normally open.
3. Blue = open in winter, closed in summer.
4. Yellow = closed in winter, open in summer.
5. Tags should be engraved on both sides.

3.04 APPLICATION OF MARKERS AND STENCILS

A. Piping runs throughout the Project including those above lift-out ceilings, under floor and those exposed to view when access doors or access panels are opened shall be identified by means of pipe markers and stencils. Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by demolition of the building elements. In addition to pipe markers and stencils, arrow markers shall be used to indicate direction of flow.

B. As a minimum, locate pipe markers and stencils as follows:

1. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.
2. Every 10 feet in exposed and concealed areas on all piping systems. Provide at least one (1) pipe marker in each room on all piping systems.
3. At each branch or riser take off on piping systems, excluding short takeoffs for fixtures and terminal units.
4. Provide a pipe marker or stencil and an arrow marker at every point of pipe entry or exit where the pipe penetrates a wall, floor, service column or enclosure.
5. Provide pipe markers and arrow markers at intervals not exceeding 40 feet.
6. At access doors, manholes and similar access points that permit view of concealed piping.
7. Near major equipment items and other points of origination and termination.
8. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed and visible from floor.

C. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

D. Provide a double-ended arrow marker when flow can be in either or both directions.

E. Indicate delivered water temperature on domestic hot water supply and return lines.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify valves in main and branch piping with tags.

I. Identify air terminal units and radiator valves with plastic nameplates.

J. Tag automatic controls, instruments and relays. Key to control schematic.

K. Provide ceiling tacks to locate valves, fan coil units, dampers or other concealed equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

L. Identify pipe utilizing copper press fittings with markers stating, “Press-Fit” adjacent to each content identification marker.

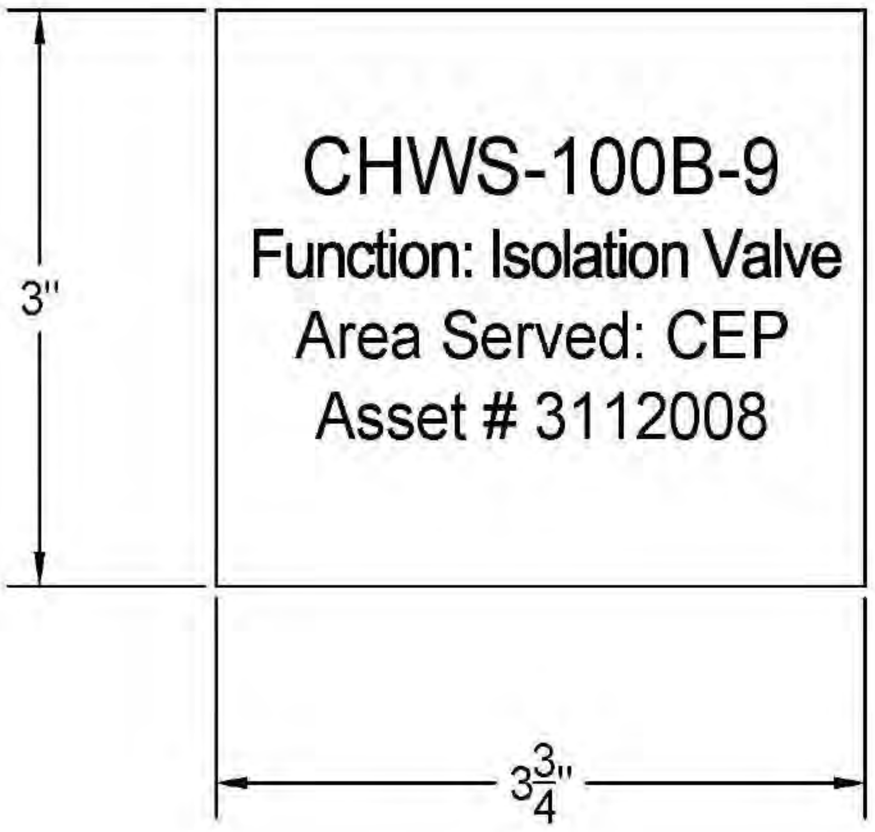
M. Identify medium pressure gas piping (14 inches WC to 5psi) with the statement, “WARNING – ½ to 5psi NATURAL GAS”.

ATTACHMENTS:

“A” – Label example with dimensions, font type and height
“B” – Valve tag naming convention

<u>ATTACHMENT "A"</u>

FONT	HT
Arial	36
Arial	18
Arial	18
Arial	18
BC C39 to 1 Medium	26



ATTACHMENT “B”
Valve Tag Naming Convention

- The first set of characters are system type designators. (Number of letters will vary per system type)

X	**X**	**X**	**X**	**X**	-	X	X	X	X	-	X	X	X

System Type Abbreviation (See Attachment “B” for abbreviations)

- A dash shall separate each set of characters.

X	X	X	X	X	**-**	X	X	X	X	-	X	X	X

Placeholder

- The middle set of characters are the building designator.

X	X	X	X	X	**-**	**X**	**X**	**X**	**X**	-	X	X	X

Building Designator (Contact Owner’s Project Manager for building number)

- A dash shall separate each set of characters.

X	X	X	X	X	-	X	X	X	X	**-**	X	X	X

Placeholder

- The last set of characters are sequential valve tag numbers.

X	X	X	X	X	-	X	X	X	X	-	**X**	**X**	**X**

Sequential Valve Tag Number
(Number of digits will vary based on quantity of valves installed)

Below is an Example for a Chilled Water Supply Valve Located in Anderson Central :

	C	**H**	**W**	**S**	**-**	**1**	**0**	**0**	**B**	**-**	**9**

<u>NOTE</u>: No two valve tags shall have the same name or asset number. Obtain valve tag names from Owner’s Property Manager when installing valves within existing systems.

END OF SECTION 20 05 53 00

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SECTION 20 07 00 00 - EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install equipment insulation and covering indicated by the Contract Documents with supplementary items necessary for proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM C168 - Terminology Relating to Thermal Insulation Materials.
3. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded- Hot-Plate Apparatus.
4. ASTM C195 - Mineral Fiber Thermal Insulating Cement.
5. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
6. ASTM C449 - Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
7. ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
8. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 - Mineral Fiber Pipe Insulation.
10. ASTM C552 - Cellular Glass Thermal Insulation.
11. ASTM C553 – Mineral Fiber Blanket and Felt Insulation.
12. ASTM C578 – Rigid, Cellular Polystyrene Thermal Insulation.
13. ASTM C591 – Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C612 – Mineral Fiber Block and Board Thermal Insulation.
15. ASTM C921 - Jackets for Thermal Insulation.

16. ASTM C1126 – Faced or Unfaced Rigid Celluar Phenolic Thermal Insulation.
17. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
18. ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
19. ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
20. ASTM E96 - Water Vapor Transmission of Materials.
21. NFPA 90 – Air Conditioning and Ventilation Systems.
22. NFPA 255 - Surface Burning Characteristics of Building Materials.
23. UL 723 - Surface Burning Characteristics of Building Materials.

1.04 QUALITY ASSURANCE

A. All equipment requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.

B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s submittal data for this section of the Specifications. No material shall be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

C. Application Company Qualifications: Company performing the Work of this Section must have minimum three (3) years experience specializing in the trade.

D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.

E. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be acceptable.

1.05 SUBMITTALS

A. Product Data:

1. Provide product description, service application, list of materials, “k” value, “R” value, mean temperature range, and thickness for each service and location.
2. Manufacturer’s Installation Instructions: Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.
3. Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type.

B. Operation and Maintenance Data:

1. Provide manufacturer’s recommendations for care and protection.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the Project Site in original factory packaging, labeled with manufacturer’s identification including product thermal ratings and thickness.

B. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

C. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

D. Maintain required ambient temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Owens-Corning (Type E1/Type E2).

B. Certainteed Corporation (Type E1 / Type E2).

C. Knauf Corporation (Type E1 / Type E2).

D. Dow Chemical Company (Type E3).

E. Johns Manville Corporation (Type E1 / Type E2).

F. Armstrong/Armacell (Type E5).

G. Koolphen Products Company (Type E6).

H. Resolco International bv (Insul-Phen) (Type E6).

I. Pittsburgh Corning (Type E7).

J. Aluminum Jacket: Fosters/Childers

K. Calsilate/Johns Manville (Type E8).

2.03 INSULATION MATERIALS

A. Type E1: Flexible fiberglass or mineral fiber blanket; ASTM C553; 'k' value of 0.24 at 75 degrees F; 2.0 lb/cu ft density.

B. Type E2: Rigid fiberglass or mineral fiber board; ASTM C612; 'k' value of 0.24 at 75 degrees F; 6.0 lb/cu ft density.

C. Type E3: Molded closed cell poyisocyanurate insulation; ASTM E96, ASTM C177, 'k' value of 0.18 at 75 degrees F; ASTM D2842, maximum water absorption value of 0.05 lb/ft^2.

D. Type E4: Mineral Wool; ASTM C 547; preformed insulation high temperature insulation; 'k' value of 0.35 at 300 degrees F.

E. Type E5: Closed cell, chemically neutral, neoprene insulation, 'k' value of 0.27 at 75 degrees F; sheet form.

F. Type E6: Phenolic closed cell, ASTM C1126 rigid foam, 2.2 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.13 at 75 degrees F.

G. Type E7: Rigid cellular glass; ASTM C552; ‘k’ value of 0.29 at 75 degrees F; 7.5 lb/cu ft density. 0 permeability (Wet Cup Method) ASTM E96.

H. Type E8: Calcium-Silicate; calsil

2.04 ACCESSORIES

A. Adhesives: Non-shrinking, permanently flexible, compatible with insulation. Use Childers CP-82 adhesive for general purpose. For calcium silicate, use Childers CP-97 fibrous adhesive.

B. Sealants: For general purpose to seal the end of insulation, use Childers CP-30 L.O. sealant.

C. Insulating Cement: ASTM C195; hydraulic setting mineral wool; Ryder one-coat.

D. Wire Mesh: Corrosive-resistant metal; 1 inch hexagonal pattern.

E. Primer: Use Childers CP-50 diluted 50 percent with water primer to seal over insulating cements and fibrous adhesives prior to finish coating.

F. Finish Coats: For general purpose, use Childers CP-30 L.O., reinforce with glass cloth. For calcium silicate, use Childers CP-50 finish coat reinforced with canvas jacket. For finish coat over closed cell elastomeric, use Childers CP-17 or Armstrong "Finish" acrylic finish.

PART 3 - PREPARATION

3.01 PREPARATION

A. Verify that surfaces are clean, foreign material removed, and dry.

B. Maintain required ambient temperature during and after installation for minimum period of 24 hours.

C. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Do not insulate factory insulated equipment.

D. On exposed equipment, locate insulation and cover seams in least visible locations.

E. Apply insulation close to equipment by grooving, scoring and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires or bands.

F. Fill joints, cracks, seams and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

G. For insulated cold equipment containing fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.

2. Finish with glass cloth and vapor barrier adhesive.

3. Insulate entire system.

H. For insulated equipment containing fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

2. Finish with glass cloth and adhesive.

3. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges or unions, but bevel and seal ends of insulation.

4. For hot equipment conveying fluids over 140 degrees F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.

I. Inserts and shields:

1. Application: Equipment 2 inches in diameter or larger.

2. Shields: Galvanized steel between hangers and inserts.

3. Insert location: Between support shield and equipment and under the finish jacket.

4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert material: Heavy density insulating material suitable for the planned temperature range.

6. Manufacturer shall be responsible to size the length of shield required to prevent insulation from breaking.

J. Finish insulation at supports, protrusions and interruptions.

K. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket. The longitudinal joint of the jacketing shall be placed with overlap directed to bottom of pipe. The jacketing shall be overlapped a minimum of 3 inches, and it shall be held in place using ¾ inch bands applied at 12 inches on center. Securing of the jacket shall be made by the use of 1-inch x 0.016-inch aluminum or stainless steel bands and seals. The shields at support points shall be secured with 1/2-inch or 0.020 inch stainless steel bands and seals. Ferrous metal surfaces shall be primed with a red lead oxide primer. The metal jacketing and fitting covers shall be fabricated of 9.016 inch aluminum or stainless steel with a smooth finish.

L. For exterior applications, provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

M. Each chilled water pump shall be insulated up to the face of the flanges on the piping connection to the pump and any bare metal that Projects over the bed plate of the pump and from which condensation might drip onto the floor. Heating hot water pumps and condensate return pumps shall not be insulated but the insulation of the connecting piping shall be beveled to the face of the pipe flange connection to the pump flange

3.03 TESTING

A. Verify that equipment has been tested before applying insulation materials.

3.04 EQUIPMENT INSULATION APPLICATION AND THICKNESS SCHEDULE

Equipment	Application	Insulation Type	Insulation Thickness
Domestic Hot Water Storage Tanks	All	E2, E3 or E7,E8	1-½”
Domestic Cold Water Storage Tanks	All	E2, E3 or E7	1-½”
Domestic Cold Water Pressure Tanks	All	E2, E3 or E7	1-½”
Hot Thermal Storage Tanks	All	E8	2”
Boiler Feed Water Storage Tanks	All	E8	2”
Steam Condensate Receivers	All	E8	1-½”
Condensate Tanks	All	E7,E8	1”
Hot Water Expansion Tanks	All	E8	1”
Heat Exchangers/Converters	35-75 Deg F	E7	2”
	75-150 Deg F	E8	2”
	151-300 Deg F	E8	2-½”
	Above 300 Deg F	E8	3”
Chilled Water Expansion Tanks	All	E6 or E7	1”
Air Separators	All	E6 or E7	1”
Deaerators	All	E8	2”
Flue Gas Breeching	All	E8	3”
Induced Draft Fan Scrolls	All	E8	3”
Flue Stacks to Roof	All	E4 or E8	3”
Boiler and Flue Boxes	All	E8	3”
Boiler Drum Heads	All	E8	3”
Chiller Cold Surfaces (Not Factory Insulated)	All	E5 or E7	1-½”
Chemical Feed (Chilled/Hot Water)	All	E6	¾”
Muffler	All	E4	4”

END OF SECTION 20 07 00 00

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SECTION 20 07 19 00 - PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and division 01 specification sections, apply to this section.

B. Specifications throughout all divisions of the project manual are directly applicable to this section, and this section is directly applicable to them.

1.02 SUMMARY

A. Perform all work required to provide and install piping insulation, jackets and accessories indicated by the contract documents with supplementary items necessary for proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this contract shall be applicable to this project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASTM B209 - aluminum and aluminum-alloy sheet and plate.
2. ASTM C168 - terminology relating to thermal insulation materials.
3. ASTM C177 - steady-state heat flux measurements and thermal transmission properties by means of the guarded- hot-plate apparatus.
4. ASTM C195 - mineral fiber thermal insulating cement.
5. ASTM C335 - steady-state heat transfer properties of horizontal pipe insulation.
6. ASTM C449 - mineral fiber hydraulic-setting thermal insulating and finishing cement.
7. ASTM C518 - steady-state thermal transmission properties by means of the heat flow meter apparatus.
8. ASTM C534 - preformed flexible elastomeric cellular thermal insulation in sheet and tubular form.
9. ASTM C547 - mineral fiber pipe insulation.
10. ASTM C552 - cellular glass thermal insulation.
11. ASTM C578 - rigid, cellular polystyrene thermal insulation.
12. ASTM C585 - inner and outer diameters of rigid thermal insulation for nominal sizes of pipe and tubing (nps system).

13. ASTM C591 - unfaced preformed rigid cellular polyisocyanurate thermal insulation.
14. ASTM C610 - molded expanded perlite block and pipe thermal insulation.
15. ASTM C921 - jackets for thermal insulation.
16. ASTM C1126 - faced or unfaced rigid celluar phenolic thermal insulation.
17. ASTM D1056 - flexible cellular materials - sponge or expanded rubber.
18. ASTM D1667 - flexible cellular materials - vinyl chloride polymers and copolymers (closed cell foam).
19. ASTM D2842 - water absorption of rigid cellular plastics.
20. ASTM C795 - insulation for use over austenitic steel.
21. ASTM E84 - surface burning characteristics of building materials.
22. ASTM E96 - water vapor transmission of materials.
23. NFPA 255 - surface burning characteristics of building materials.
24. UL 723 - surface burning characteristics of building materials.

1.04 DEFINITIONS

A. Concealed: areas that cannot be seen by the building occupants.

B. Interior exposed: areas that are exposed to view by the building occupants, including underneath countertops, inside cabinets and closets, and in mechanical, electrical and plumbing chases.

C. Interior: areas inside the building exterior envelope that are not exposed to the outdoors.

D. Exterior: areas outside the building exterior envelope that are exposed to the outdoors, including building crawl spaces and loading dock areas.

E. Mechanical and electrical rooms: areas inside the building that house pumps, fans, heat exchangers, water heaters and boilers, chillers, switchgear, transformers, and other equipment for the hvac, plumbing and electrical systems.

1.05 QUALITY ASSURANCE

A. All piping requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these specifications.

B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet nfpa for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement.

1. Certificates to this effect shall be submitted along with contractor's submittal data for this section of the specifications.
2. No material shall be used that, when tested by the astm e84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

C. Application company qualifications: company performing the work of this section must have minimum three (3) years experience specializing in the trade.

D. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.

E. All insulation shall be applied in strict accordance with these specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable.

1.06 SUBMITTALS

A. Product data:

1. Provide product description, list of materials, "k" value, "r" value, mean temperature range, and thickness for each service and location.
2. Samples: when requested, submit three (3) samples of any representative size illustrating each insulation type

B. Operation and maintenance data:

1. indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the project site in original factory packaging, labeled with manufacturer's identification including product thermal ratings and thickness.

B. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

C. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Insulation:

1. Owens-corning (type p1).

2. Certainteed corporation (type p1).
3. Johns manville corporation (type p1).
4. Knauf corporation (type p1).
5. Dow chemical company (type p2).
6. Armstrong/armacell (armaflex) (type p3).
7. Rbx industries/rubatex (type p3).
8. Mineral products of texas (type p4).
9. resolco international by (insul-phen) (type p5).
10. foamglas (cellular glass) by pittsburgh corning (type p6).

B. Jackets:

1. Childers products company.
2. Pabco.
3. Rpr products, inc.
4. Alpha.
5. Venture tape corporation
6. Foamglas

2.03 INSULATION

A. Type p1: fiberglass preformed insulation; astm c 547; minimum 3.0 lb/cu ft density, astm c335,'k' value of 0.23 at 75 degrees f; noncombustible.

B. Type p2: molded closed cell polyisocyanurate insulation; astm e96, maximum water vapor transmission rating of 0.005 perm-in; astm c518, 'k' value of 0.20 at 75 degrees f; astm d2842, water absorption value of 0.05 lb/ft^2.

C. Type p3: elastomer, closed cell, flexible, insulation; astm e96; maximum vapor transmission rating of 0.20 perms; astm c 518; 'k' value of 0.27 at 75 degrees f.

D. Type p4: mineral wool; astm c 547; preformed insulation high temperature insulation; 'k' value of 0.35 at 300 degrees f.

E. Type p5: phenolic closed cell, astm c1126 rigid foam, 2.2 lbs. Nominal density, cfc free; astm c518, 'k' value of 0.13 at 75 degrees f. (note material thickness limit is 3 inches as tested in accordance with astm e84).

F. Type p5a: phenolic closed cell insulation; astm e96, maximum water vapor transmission rating of 0.02 perm-in; astm c1126 rigid foam, 3.75 lbs. Nominal density, cfc free; astm c518, 'k' value of 0.16 at 75 degrees f. (note material thickness limit is 3 inches as tested in accordance with astm e84).

G. Type p5b: phenolic closed cell insulation; astm e96, maximum water vapor transmission rating of 0.02 perm-in; astm c1126 rigid foam, 5.0 lbs. Nominal density, cfc free; astm c518, ‘k’ value of 0.21 at 75 degrees f. (note material thickness limit is 3 inches as tested in accordance with astm e84).

H. Type p6: cellular glass, astm c552, 7.5 lbs./cu.ft, density, astm e96 (wet cup method) 0.00 water vapor perm , astm c518 ‘k’ value of 0.29 at 75 degrees f.

I. Type p7: hydrous calcium silicate: astm c177 and astm c335 type 1, 14.5 lb/ft^3, astm c518 “k” value: 0.41@200 deg. F.

J. Type p8: ceramic blanket

2.04 JACKETS

A. Jacket materials:

1. Factory applied jackets: white kraft bonded to reinforced foil vapor barrier with self-sealing adhesive joints.
2. Pvc jackets: ul listed 25/50 rated per astm e 84, uv resistant, minimum insulation thickness 0.020 inches for piping outside diameters up to 18 inches and 0.030 inches for i piping outside diameters above 18 inches.. Standard manufactured pvc cover fittings cover system consisting of one-piece, pre-molded, pvc covers with fiberglass inserts manufactured from 20-mils thick, high-impact, ultraviolet-resistant. Use ultraviolet resistant adhesive as recommended by the manufacturer.
3. Fiberglass cloth reinforcing mesh: #10 glass cloth with minimum weight of 3.9 ounces per square yard.
4. Aluminum jackets: astm b 209; 0.020 inch thick; smooth finish with factory applied moisture barrier.
5. Stainless steel jackets: type 304 stainless steel; 0.010 inch thick; smooth finish.
6. Factory applied jacket (like alpha style: vr-rhd): provide factory applied asj white triple ply laminate polypropylene, mold resistant, metallized polyester vapor barrier film backing.
7. Venture 1577 w/u, 0 perm and mold resistant jacket material, 5 ply laminate with 6 mil film on with adhesive on one side.. This mold resistant jacket is to be used with phenolic closed cell insulation used for applications where type 5a and 5b insulation is used on existing chilled piping being repaired or being modified.

B. Interior concealed applications:

1. Type p1 insulation: provide factory applied asj white kraft foil vapor barrier.
2. Type p3 insulation: finish coat is not required.
3. Type p4 insulation: cover with a canvas jacket, adhesive prime coat # cp-52 and childers #cp-50a hv2 lagging adhesive.

4. Type p5 and p5a, 5b insulation: provide venture jacketing material on piping where condensation can occur or where it is used on existing chilled water piping, equipment drain piping transporting chilled condensate form cooling coils, and roof storm drain piping transporting cold rain water from the building roof.
5. type p6 insulation: provide pittcoat 404 or pre-molded pvc covers per manufacturer's recommendations.

C. Interior - exposed applications:

1. Type p1, and p2 insulation: provide factory applied asj white kraft foil vapor barrier. Also finish with canvas jacket or #10 glass membrane with childers cp-50 or approved equal finish. Apply sizing for finish painting. Verify jacket is suitable for applications.
2. Type p3 insulation: finish coat is not required.
3. Type p4 insulation: cover with a canvas jacket and childers cp-50 lagging adhesive.
4. Type p5 insulation is used on hot water piping: venture jacketing material.
5. Type p5 and p5a insulation: provide venture jacketing material on piping where it is used on existing chilled water piping, equipment drain piping transporting chilled condensate form cooling coils, and roof storm drain piping transporting cold rain water from the building roof where condensation can occur.
6. Type p6 insulation: aluminum jacketing.
7. All exposed insulated piping within eight feet of the floor shall be protected with an aluminum jacket material to protect the insulation jacketing material from being torn or punctured.

D. Exterior applications:

1. Insulate piping system as indicated under interior - exposed applications, prior to final jacket installation.
2. Provide electric heat tracing for all exterior small bore piping 2 inch and smaller where water may be susceptible to freezing due to intermittent flow conditions. **(note engineer needs to show location heat trace piping on piping and capacity and size on electrical drawings,)**
3. Final jacket cover shall be aluminum or stainless steel jacket having integral moisture barrier with seams located at 2 or 10 o'clock position of horizontal piping. All laps must be minimum 2 inches.
4. Type p1 insulation: finish with #10 glass membrane and childers cp-11, prior to the final jacket installation.
5. P6 insulation for above ground installations: provide (50 mil thickness) self sealing non- metallic bituminous compound reinforced with glass fiber membrane with 1 mil aluminum top film jacketing for both chilled water and hot water piping (pittwrap cw plus). Metal jacketing is required where the film jacketing material is exposed to ultraviolet rays.

6. P6 insulation for underground installations: provide factory applied (50 mil thicknesses) self sealing membrane bituminous compound reinforce with glass fiber for chilled water piping (pittwrap iw 50). Metal jacketing material is not required for buried pipe.

E. Mechanical and electrical rooms

1. Type p1, and p2 insulation: provide factory applied asj white kraft foil vapor barrier. Also finish with canvas jacket or #10 glass membrane with childers cp-50 or approved equal finish. Apply sizing for finish painting. Verify jacket is suitable for applications.
2. Type p3 insulation: finish coat is not required.
3. Type p4 insulation: cover with a canvas jacket and childers cp-50 lagging adhesive.
4. Type p5 insulation is used on hot water piping: provide factory applied asj white kraft foil vapor barrier.
5. Type p5 and p5a insulation: provide venture jacketing material on piping where it is used on existing chilled water piping, equipment drain piping transporting chilled condensate from cooling coils, and roof storm drain piping transporting cold rain water from building roof where condensation can occur.
6. Type p6 insulation: provide triple ply laminate polypropylene, mold resistant with a metal foil and polyester vapor barrier film backing
7. All exposed insulated piping within eight feet of the floor shall be protected with an aluminum or stainless jacket material to protect the insulation jacketing material from being torn or punctured.

2.05 INSERTS SUPPORTS AND SHIELDS

A. Application: piping 2 inches diameter or larger for all systems except direct buried.

B. Shields shall be made of galvanized steel or made of black iron painted on both sides with a minimum two coats of aluminum paint. Required metal shield sizes are as follows:

Nominal ips (inches)	Metal thickness (gage)	Minimum lengths of shield (inches)
2	14	12
2-½ to 6	12	16
8 and above	10	20

C. Depending on the type of pipe support design, stainless steel bands or aluminum bands are required to keep shield material next to the jacketing material.

D. Inserts for shields shall be manufactured of 7.5 lb/cu. Ft. Density cellular glass or 5.0 lb/cu. Ft. Density cellular phenolic insulating material suitable for the planned temperature range. Provide factory fabricated inserts with integral galvanized pipe saddles. Inserts shall be the same thickness as the adjacent insulation.

2.06 INSULATION ACCESSORIES

A. Insulation bands: 3/4 inch wide; 0.007 inch thick galvanized steel when exposed to interior environment, .010 inch thick stainless steel or 0.015 inch thick aluminum when exposed to harsh humid interior environment or outside environment.

B. Metal jacket bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match jacket.

C. Insulating cement: astm c 195; hydraulic setting mineral wool; ryder one-coat.

D. Sealants: use at valves, fittings and where insulation is terminated. Brush apply sealant to end of insulation and continue along pipe surface. Provide childers cp-70/cp-76 or equivalent sealant.

E. Adhesives: use to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide childers cp-82 or approved equal as general purpose adhesive. Use childers cp-97 fibrous adhesive for calcium silicate or when adhering pipe saddles and shields to the insulation.

F. Primers: provide childers cp-50 diluted 50 percent with water or pittcoat 300 primer thinned with mineral spirits to cover insulating cements prior to finish coating.

G. Finish: provide childers cp-30 l.o. As a general purpose finish to coat the longitudinal seams and butt joints of vapor barrier jackets or glass cloth jackets. Use childers cp-50 reinforced with glass cloth as an adhesive and sizing for canvas and in other locations as indicated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that piping has been pressure tested before applying paint and insulation materials.

B. Thoroughly clean all surfaces to be insulated as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application of primer paint. Painting on piping where condensation is occurring on the pipe surface is strictly prohibited.

C. Provide primer coat on all piping, to include field welds and over factory applied paint/coating, in total compliance with contract documents and compatible with and approved by the insulation manufacturer. Painting must be completed and approved prior to installation of insulation. Paint shall be applied in accordance with the paint manufactures instructions, environment, and pipe surface temperatures.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Installation of insulation and jacket materials shall be in accordance with manufacturer’s published instructions.

C. Handle and install materials in accordance with manufacturer’s instructions in the absence of specific instructions herein.

D. On exposed piping, locate insulation cover seams with the ridge of the lap joint is directed down.

E. Exposed insulated piping within eight feet of the floor shall be protected with an aluminum or stainless jacket material to protect the insulation.

F. Insulate fittings, joints and valves with molded insulation of the same material and thickness as adjoining pipe. Open voids and cracks insulation shall be kept at a minimum when placing insulation on abnormal or irregular shapes. Use closed cell or recommended fill material as instructed by the insulation manufacturer to close openings. Fiberglass insulation shall not be used as a fill material on chilled water piping or fittings.

G. Continue insulation through walls, sleeves, pipe hangers, floors, and other pipe penetrations.

H. Provide dams in insulation at intervals not to exceed 20 feet on cold piping systems to prevent migration of condensation or fluid leaks. Indicate visually where the dams are located for maintenance personnel to identify and also provide dams at butt joints of insulation at fittings, flanges, valves, and hangers.

I. Insulate entire system including fittings, valves, flanges and strainers. Use closed cell insulation on cold piping system flexible connections, expansion joints and unions, bevel and seal ends of insulation and continue sealant a minimum of 4 inches along the piping, unless stated otherwise.

J. For hot piping conveying fluids 140 degrees f or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation. Continue sealant a minimum of 4 inches along the piping.

K. For hot piping conveying fluids over 140 degrees f, insulate flanges and unions, including those at equipment, and place plastic tape labels on insulation to indicate location of concealed flange or union connections.

L. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3 inches). Where insulation terminates, it shall be neatly beveled and finished. All materials used shall be fire retardant or nonflammable.

M. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall be sealed. Where insulation with a vapor barrier terminates, seal off with vapor barrier continuous to the surface being insulated. Ends shall not be left raw.

N. Where pipe chases are tight, adequate provision shall be made at the rough-in stage using offset fittings or other means (except springing the pipe) to ensure that insulation can be applied throughout the length of the pipe.

O. Paint exposed pipe insulation.

P. Where canvas finish is specified, use lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

   1. On canvas jacketed systems where seam joints at fittings are rough, they shall be covered with an application of insulating cement and smoothed with a trowel before the canvas is applied with adhesive. The canvas must be free of wrinkles and have a smooth, neat appearance.

Q. Inserts, supports, and shields

   1. Shields

a) Install between pipe hangers or pipe hanger rolls and inserts. Curved metal shields shall be used between the hangers or support points and at the bottom of insulated pipe 2 inches and larger.

b) Hangers shall support the load of the insulated pipe section on the outside of the insulation and shall not be in direct contact with the pipe.

c) Manufacturer shall be responsible to size the length of shield required to prevent insulation from breaking.

d) Provide rigid insulation at each support point, a minimum of 4 inches longer than shield length.

e) Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe.

2. When installing phenolic insulation provide a 5 lb. Density insert of same thickness and contour as adjoining 3.75 lb. Density insulation, between the support shield and piping, and under the finish jacket, on piping 1½ inch diameter or larger, to prevent insulation from sagging at support points. Provide inserts for 180-degree arc and not less than 2 inches more than the length of the pipe support shield or minimum 12 inches long (whichever is greater). Adhere the pipe support shield to insulation with a ul approved adhesive that meets e-84 requirements.

3. Seal all insulation at supports, protrusions and interruptions. Maintain vapor barrier with finish coat.

3.03 MAINTENANCE AND MODIFICATIONS TO EXISTING CHILLED WATER SYSTEM PIPING INSULATED WITH PHENOLIC FOAM INSULATION

A. Reinsulate existing piping systems after repairs have been performed in the same manner as the original installation unless:

1. The nature of damage to the insulation indicates that the system was not insulated properly, and that installation of flashing will be necessary where leaks occur.

a. increasing the thickness of the insulation may be required when condensation occurs.

b. provide insulation expansion joints where large cracks or gaps occur.

B. Materials:

1. When possible carefully remove existing insulation material so it can be reapplied, and provide temporary protection to adjacent insulation material to prevent damage while repairs are underway.

2. When performing a hot tap, maintenance to a strainer, or adding a mechanical component or similar to an operating chilled water system, apply temporary insulation to prevent moisture damage to exposed insulation material. Qualified insulation subcontractor personnel shall assist in the following:

a. Strainers; dry the strainer body prior to installing the insulating cap. Ensure that the exposed insulation and insulating cap is dry and free of any contamination. Tape in place then finish with fab cloth and vapor barrier mastic.

b. Hot tap: to eliminate the possibility of moisture migration into the existing insulation, remove the complete section of the pipe covering where the operation will occur. Apply duct wrap on the raw ends of the adjacent insulation in both directions at a 12 inch length. Use fsk tape to secure the wrap. After completion of the hot tap, remove the temporary insulation and inspect the protected sections to ensure the sections are dry and free from contaminates. Re-insulate and seal the circumferential joints with foster product joint sealant 30-45 foam seal or equivalent. Apply fsk tape at the seams to match the existing facing system.

c. Use freezing blankets to install new mechanical components to an existing chilled water piping section. Remove enough insulation to install the freezing blankets plus one additional section in either direction. To eliminate the possibility of moisture migration, remove the complete section of the pipe covering where the operation will occur. Apply duct wrap on the raw ends of the adjacent insulation in both directions at a 12 inch length. Use fsk tape to secure the wrap. After completion of the procedure, remove the temporary insulation and inspect the protected sections to ensure that the insulation sections are dry and free from contaminates. Re-insulate and seal the circumferential joints with a foster product joint sealant 30-45 foam seal or equivalent. Apply tape at the seams to match the existing facing system.

C. Maintenance and inspection methods

1. Conduct periodic inspections as determined by the university, to address the following :

a. Replace missing insulation and protect adjacent insulation which can become burned or wet after maintenance has been performed to the system.

b. Repair leaks or spills and remove and replace damaged insulation.

c. Repair breaks, tears, cracks, or punctures of the vapor barrier or protective covering. Verify that the existing insulation is dry and if wet replace the entire affected section as described in this section.

d. On piping exposed to the outdoor environment, replace the affected section of insulation as described in this section and use galvanized steel, aluminum or stainless steel to protect the insulation from being crushed due to foot traffic or maintenance equipment. Pvc is appropriate for interior areas not subject to foot traffic.

3.04 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE

A. In no case shall installed piping insulation have insulation thicknesses that are less than what is required by local energy codes and ashrae 90.1 (whichever is more stringent), based on comparable insulation conductivity values at the specified mean rating temperature.

B. Type 5a and 5b insulation is only used where it is being replaced on existing pipe and thickness of the replacement insulation shall match the existing insulation thickness.

Piping systems	Location	Type	Pipe size	Insulation Thickness
Domestic cold water, soft water, make-up water	Interior concealed	P1	1-1/2" & smaller	1/2”
			2" to 4"	1/2”
			5" & larger	1/2”
	Interior exposed	P5	1-1/2" & smaller	3/4”
			2” to 4”	3/4”
			5” & larger	1”
	Interior exposed	p6	1-1/2” & smaller	1”
			2” to 4	1”
			5” & larger	1-1/2”
	Exterior	p5	All sizes	1”
		p6	4” and smaller	1”
			5” & larger	1-1/2”
Domestic hot water, tempered water (maximum 200 degrees f)	Interior concealed	P1	2” & smaller	1"
			2-1/2”& larger	1-1/2”
	Interior	P5	1-1/2” & smaller	3/4”
			2” to 4”	1”

Piping systems	Location	Type	Pipe size	Insulation Thickness
	exposed		5” & larger	1-1/2”
			4” and smaller	1”
		P6	5” & larger	1-1/2”
	Exterior	P5	All sizes	1-1/2”
		P6	All sizes	1-1/2”
Fire protection water (40 degrees f – nominal)	Exterior	P5	4” & smaller	3/4”
			6” & larger	1”
		P6	4” & smaller	1”
			6 “& larger	1-1/2”
Underside of all roof / overflow drain bodies and related horizontal roof drain lines to vertical leader	Interior exposed	P5	2” to 4”	3/4”
			5” & larger	1”
		P6	2” to 4”	1”
			5” & larger	1-1/2”
	Interior concealed	P1	2" to 4”	1/2"
			5” & larger	1/2”
Floor drain bodies and related horizontal sanitary drain lines above floor that receive cold condensate drainage.	Interior exposed	P5	2” to 4”	3/4"
			5” & larger	1"
		P6	2” to 4”	1”

Piping systems	Location	Type	Pipe size	Insulation Thickness
			5” & larger	1-1/2”
	Interior concealed	P1	2” to 4”	1/2”
			5” & larger	1/2
Cold condensate drain lines	Interior	P5	All sizes	3/4”
		P6	4” & smaller	1”
			6” & larger	1-1/2”
	Interior concealed	P3	All sizes	3/4”
		P6	All sizes	1"
Heating hot water (maximum 250 degrees f)	Interior exposed	P5	2-1/2” & smaller	1"
			3" & larger	1-1/2”
		P5	2-1/2” & smaller	1-1/2”
			3" & larger	2”
	Interior concealed	P5	2-1/2” & smaller	1-1/2”
			3" & larger	2-1/2”
		P5	2-1/2” & smaller	1"
			3" & larger	1-1/2”
		P5	2-1/2” & smaller	1-1/2”
			3" & larger	2”
	Exterior	P5	2-1/2” & smaller	1"

Piping systems	Location	Type	Pipe size	Insulation Thickness
			3" & larger	1-1/2”
		P5	2-1/2” & smaller 3" & larger	1-1/2” 2”
Chilled water	Interior concealed	P5	4" & smaller	1-1/2”
			6" & larger	2"
	Interior Exposed	p5	4” & smaller	1-1/2”
			6” & larger	2”
	Exterior	P5		
			4" & smaller 6” & larger	1-1/2” 2”
Refrigerant suction piping (35 degrees f – nominal)	All	P3	2-1/2” & smaller	3/4"
Heat recovery water	All	P5	1" & smaller	1"
			1-1/2" to 2-1/2"	1-1/2"
		P7	3" to 6"	1-1/2“
			8" & larger	2-1/2”
Engine exhaust	All	P4	Less then 1"	2-1/2"
			1" to 3"	3"
		P8	4" & larger	4"
Low pressure steam, boiler feedwater, steam condensate return, compresses air discharge, boiler blowdown	All	P7	2-1/2" & smaller	2"
			3” to 6"	3”
			8"& larger	3-1/2"

Piping systems	Location	Type	Pipe size	Insulation Thickness
(201 degrees f to 250 degrees f)		P7	Less then 1-1/2”	1-1/2"
			1-1/2” & larger	2"
Medium temp. Hot water and steam (251 degrees f to 350 degrees f)	All	P7	Less then 1”	1-1/2"
			1" to < 1-1/2"	2-1/2"
			1-1/2" & larger	3"
High temp. Hot water (351 degrees f to 400 degrees f) and steam (351 degrees f to 600 degrees f)	All	P7	Less then 1”	2-1/2"
			1” to < 4"	3"
			4" & larger	4”
Brine systems, cryogenics (minus 30 degrees f to 0 degrees f)	All	P5	3” & smaller 4” and larger	1-1/2” 2”
		P6	3” & smaller 4” and larger	2” 2-1/2”
Brine systems, cryogenics (0 degrees f to 34 degrees f)	All	P5	5” & smaller	1”
			6” and larger	1-1/2”
		P6	5” & smaller 6” and larger	1-1/2” 2”

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SECTION 20 08 00 00 - FIRE SUPRESSION/PLUMBING/HVAC SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. The purpose of this Section is to define responsibilities in the Commissioning process. Additional system testing is required within individual Specification Sections.

B. Ensure that all systems are operating in a manner consistent with the Contract Documents. General Commissioning requirements and coordination are detailed in Division 01. Execute all Commissioning responsibilities assigned and include the cost of Commissioning in the Contract price.

C. HVAC systems to be commissioned include the following: [Edit or add to the following scope as appropriate to the Project.

1. Chilled Water Systems
2. Cooling Tower
3. Hot Water and Steam PRV Station
4. Steam Boiler System
5. Pumps
6. Heat Exchangers
7. Air Handling Units
8. Fans
9. Piping Systems
10. Ductwork Systems
11. Fire, Fire/Smoke and Volume Dampers
12. Chemical Treatment
13. Roof Top Packaged DX Units
14. Split Systems
15. Fan Coil Units
16. Terminal Units
17. Unit Heaters
18. Building Automation System

D. Plumbing Systems to be commissioned include the following:

  1. Sanitary Waste and Vent
  2. Roof and Storm Drainage
  3. Laboratory (Chemical) Waste and Vent
  4. Grease/Oil Laden Waste and Vent
  5. Sump/Ejector Pumps
  6. Domestic Water Booster Pumps
  7. Domestic Water Storage/Break Tank
  8. Water Softeners
  9. Pure Water Production Equipment (R.O., D.I., etc.)
  10. Domestic Water Heaters
  11. Domestic Hot Water Circulating Pumps
  12. Domestic Cold Water Distribution
  13. Domestic Hot Water Distribution
  14. Natural Gas Distribution
  15. Medical Air Compressors and Vacuum Pumps
  16. Laboratory Air Compressors And Vacuum Pumps
  17. Medical Compressed Gas Cylinder Manifolds
  18. Laboratory Compressed Gas Manifolds
  19. Medical Gas and Vacuum System Alarms
  20. Laboratory Gas and Vacuum System Alarms
  21. Medical Gas and Vacuum Distribution
  22. Laboratory Gas and Vacuum Distribution
  23. Plumbing Fixtures
  24. Plumbing Systems/Emergency Power Source Integration
  25. Plumbing Systems/Building Automation System Integration

E. Fire Protection Systems to be commissioned include the following:

  1. Fire Pump
  2. Wet Standpipe
  3. Wet Fire Sprinkler

4. Dry Fire Sprinkler
5. Pre-Action Fire Sprinkler
6. Chemical Fire Suppression
7. FACP
8. Fire Protection Systems/Emergency Power Source Integration
9. Fire Protection Systems/Fire Alarm System Integration
10. Fire Water Tank and piping system including valves, high/low level, over flow, metering, basin and circulation loop.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.04 DEFINITIONS

A. Commissioning: A systematic process confirming that building systems have been installed, properly started, and consistently operated in strict accordance with the Contract Documents, that all systems are complete and functioning in accordance with the Contract Documents at Substantial Completion, and that Contractor has provided Owner adequate system documentation and training. Commissioning includes deferred and/or seasonal tests as approved by Owner.

B. Commissioning Plan: Document prepared by Contractor and approved by Owner that provides the structure, schedule, and coordination plan for the Commissioning process from the construction phase through the warranty period. The Commissioning Plan must satisfy The University’s test requirements.

C. Commissioning Team: Working group made up of representative(s) from the Architect/Engineer (A/E), Contractor, Test, Adjust, and Balance (TAB) Firm, Building Automation System (BAS) provider, specialty manufacturers and suppliers, and Owner. Contractor will provide ad-hoc representation of subcontractors on the Commissioning Team as required for implementation of the Commissioning Plan.

D. Deferred Tests: Functional Performance or Integrated System Tests performed after Substantial Completion due to partial occupancy, partial equipment acceptance, seasonal requirements, design, or other Site conditions that prohibit the test from being performed prior to Substantial Completion.

E. Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents.

F. Factory Testing: Testing of equipment at the factory, by factory personnel with an Owner’s representative present if deemed necessary by Owner.

G. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configuration and steps required to determine if the system is performing and functioning properly. Contractor prepares these procedures to document Functional Performance Tests.

H. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems executed by Contractor. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Functional Performance Tests are executed after Start-ups and Prefunctional Checklists are complete.

I. Integrated System Test: Test of dynamic interactive function and operation of multiple systems. Integrated System Tests are tested under various modes, such as fire alarm and emergency situations, life safety conditions, power failure, etc. Systems are integrally operated through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Integrated System Tests are executed after Functional Performance Tests are complete and prior to Substantial Completion. Integrated System Tests provide verification that the integrated systems will properly function according to the Contract Documents.

J. Integrated System Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format fully describe system configurations and steps required to determine if the interacting systems are performing and functioning properly. Contractor prepares these procedures to document Integrated System Tests.

K. Prefunctional Checklist: A list of static inspections and material or component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.). The word Prefunctional refers to before Functional tests. Prefunctional Checklists must include the manufacturer’s Start-up checklist(s). Contractor shall sign Prefunctional Checklists as complete and submit with the Request for Start-up/Functional Performance Test Form.

L. Start-up: The activities where equipment is initially energized, tested, and operated. Start-up is completed prior to Functional Performance Tests.

M. Test Requirements: Requirements specifying what systems, modes and functions, etc. must be tested. Test requirements are not detailed test procedures. Test requirements and acceptance criteria are specified in the Contract Documents.

1.05 SUBMITTALS

A. Contractor shall prepare Prefunctional Checklists and Functional Performance Test (FPT) procedures and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to The University for review and approval.

B. Contractor shall provide Owner with documentation required for Commissioning Work. At minimum, documentation shall include: Detailed Start-up procedures, full sequences of operation, Operating and Maintenance data, performance data, Functional Performance Test Procedures, control drawings, and details of Owner-contracted tests.

C. Contractor shall submit to Owner installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.

D. Contractor shall review and approve other relative documentation for impact on FPT’s of the systems:

1. Shop drawings and product submittal data related to systems or equipment to be commissioned. The Subcontractor responsible for the FPT shall review and incorporate comments from The University and A/E via the Contractor.

2. Incorporate manufacturer’s Start-up procedures with Prefunctional checklists.

3. Draft Test, Adjust and Balance (TAB) Reports: Review and provide comments to Owner.

4. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT's.

5. Completed equipment Start-up certification forms along with the manufacturer's field or factory performance and Start-up test documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT's. Owner may require that system one-line diagrams and applicable Specification Section(s) be attached to the FPT documentation.

6. Final TAB Reports: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT's.

7. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 TEST EQUIPMENT

A. Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.

B. All specialized tools, test equipment, and instruments required to execute Start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Calibration shall be NIST traceable. Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

PART 3 - EXECUTION

3.01 PREPARATION

A. Construction Phase:

1. In each purchase order or subcontract that is written for changes in scope, include the following requirements for submittal data, Commissioning documentation, testing assistance, Operating and Maintenance (O&M) data, and training, as a minimum.

2. Attend Pre-Commissioning Meeting(s), Pre-Installation Meeting(s), and other Project meetings scheduled by the Contractor to facilitate the Commissioning process.

3. Provide manufacturer's data sheets and shop drawing submittals of equipment.

4. Provide additional requested documentation to the Contractor, prior to O&M manual submittals, for development of Prefunctional Checklist and Functional Performance Tests procedures.

    a. Typically, this will include detailed manufacturer's installation and Start-up, operating, troubleshooting and maintenance procedures, full details of any Owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of The University to keep the warranty in force clearly identified.

b. In addition, the installation, Start-up, and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Contractor.

c. This information and data request may be made prior to normal submittals.

5. With input from the BAS Provider and A/E, Clarify the operation and control of commissioned equipment in areas where the Specifications, BAS control drawings, or equipment documentation are not sufficient for writing detailed test procedures.

6. Prepare the specific Functional Performance Test procedures specified in Section 20 08 16. Ensure that Functional Performance Test procedures address feasibility, safety, and equipment protection and provide necessary written alarm limits to be used during the tests.

7. Develop the Commissioning Plan using manufacturer's Start-up procedures and the Prefunctional Checklists. Submit manufacturer's detailed Start-up procedures and the Commissioning Plan and procedures and other requested equipment documentation to Owner for review.

8. During the Start-up and initial checkout process, execute and document related portions of the Prefunctional Checklists for all commissioned equipment.

9. Perform and clearly document all completed Prefunctional Checklists and Start-up procedures. Provide a copy to The University prior to the Functional Performance Test.

10. Address current A/E and Owner punch list items before Functional Performance Tests. Air and water test, adjust and balance shall be completed with discrepancies and problems remedied before Functional Performance Tests of the respective air or water related systems are executed.

11. Provide skilled technicians to execute starting of equipment and to assist in execution of Functional Performance Tests. Ensure that they are available and present during the agreed-upon schedules and for a sufficient duration to complete the necessary tests, adjustments, and problem solving.

12. Correct deficiencies (differences between specified and observed performance) as interpreted by The University's Project Manager and A/E and retest the system and equipment.

13. Compile all Commissioning records and documentation to be included in a Commissioning and Closeout Manual.

14. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

15. During construction, maintain as-built marked-up Drawings and Specifications of all Contract Documents and Contractor-generated coordination Drawings. Update after completion of Commissioning activities (include deferred tests). The as-built drawings and specifications shall be delivered to The University both in electronic format and hard copies as required by The University.

16. Provide training of The University's operating personnel as specified.

17. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

B. Warranty Phase:

1. Execute seasonal or deferred tests, witnessed by The University, according to the Specifications.

d. Complete deferred tests as part of this Contract during the Warranty Period. Schedule this activity with Owner. Perform tests and document and correct deficiencies. Owner may observe the tests and review and approve test documentation and deficiency corrections.

e. If any check or test cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, execution of such test may be delayed to later in the Warranty Period, upon approval of The University. Contractor shall reschedule and conduct these unforeseen deferred tests in the same manner as deferred tests.

2. Correct deficiencies and make necessary adjustments to O&M manuals, Commissioning documentation, and as-built drawings for applicable issues identified in any seasonal testing.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.03 TESTING

A. Prefunctional Checklists and Start-up:

1. Follow the Start-up and initial checkout procedures listed in this Section and in Division 01. Start-up and complete systems and sub-systems so they are fully functional, meeting the requirements of the Contract Documents.

2. Prefunctional Checklists shall be complete prior to commencement of a Functional Performance test.

B. Functional Performance Tests:

1. Functional Performance Tests are conducted after system Start-up and checkout is satisfactorily completed. Air balancing and water balancing shall be completed before Functional Performance Tests.

C. Coordination Between Testing Parties:

1. Factory Start-ups: Factory Start-ups are specified for certain equipment. Factory Start-ups generally are Start-up related activities that will be reviewed and checked prior to Functional Performance Tests. All costs associated with factory Start-ups shall be included with the contract price unless otherwise noted. Notify the Commissioning Team of the factory Start-up schedule and coordinate these factory Start-ups with witnessing parties. The Commissioning Team members may witness these Start-ups at their discretion.

2. Independent Testing Agencies: For systems that specify testing by an independent testing agency, the cost of the test shall be included in the Contract price unless otherwise noted. Testing performed by independent agencies may cover aspects required in the Prefunctional Checklists, Start-ups, and Functional Performance Tests. Coordinate with the independent testing agency so that Owner and/or A/E can witness the test to ensure that applicable aspects of the test meet requirements.

3.04 TRAINING

A. Submit a written training plan to The University and Architect/Engineer for review and approval. Contractor’s training plan shall cover the following elements:

1. Equipment included in training.

2. Intended audience.

3. Location of training.

4. Objectives.

5. Subjects covered.

6. Duration of training on each subject.

7. Instructor for each subject.

8. Methods (classroom lecture, video, Site walk-through, actual operational demonstrations, written handouts, etc.).

9. Instructors and qualifications.

B. Contractor shall have the following training responsibilities:

1. Provide a training plan ten (10) calendar days prior to the scheduled training, in accordance with Division 01.

2. Provide Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned mechanical equipment or system.

3. Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including Start-up, shutdown, fire/smoke alarm, power failure, etc.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This representative may be the Start-up technician for the piece of equipment, the installing contractor, or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.

6. The training sessions shall follow the outline in the Table of Contents of the O&M manual and illustrate whenever possible the use of the O&M manuals for reference.

7. Training shall include:

   a. Usage of the printed installation, operation and maintenance instruction material included in the O&M manuals.

   b. Review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include Start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.

   c. Discussion of relevant health and safety issues and concerns.

   d. Discussion of warranties and guarantees.

   e. Common troubleshooting problems and solutions.

f. Explanation of information included in the O&M manuals and the location of all plans and manuals in the facility.

g. Discussion of any peculiarities of equipment installation or operation.

8. Hands-on training shall include Start-up, operation in all modes possible, including manual, shutdown, and any emergency procedures and maintenance of all pieces of equipment

9. Training shall occur after Functional Performance Tests are complete and shall be scheduled with The University's Project Manager.

C. Contractor shall cooperate with Owner and Owner's Test, Adjust, and Balance Firm for verification testing and final adjustments and balancing as may be indicated in the Contract Documents or as approved by Owner.

D. Provide manufacturer's training on each system/piece of equipment.

END OF SECTION 20 08 00 00

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SECTION 20 08 13 00 - FIRE SUPRESSION/PLUMBING/HVAC SYSTEMS PREFUNCTIONAL CHECKLIST AND START-UPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and division 01 specification sections, apply to this section.

B. Specifications throughout all divisions of the project manual are directly applicable to this section, and this section is directly applicable to them.

1.02 SUMMARY

A. This Section expands on and defines responsibilities of the Contractor regarding Prefunctional Checklists and Start-up portions of the Commissioning process and addresses validation of proper and thorough installation of mechanical, plumbing and fire protection systems.

B. Contractor shall oversee the Commissioning activities with the Contractor’s Subcontractors and the Architect/Engineer (A/E).

C. Contractor shall completely install, thoroughly inspect, Start-up, test, adjust and integrate air and water balance by Owner’s TAB firm on systems and equipment. All activities shall be documented on specific, procedural forms developed for that purpose. Contractor shall notify A/E and Owner in writing that systems are complete and ready for verification and Functional Performance Tests.

D. Completed Prefunctional Checklists for all pieces of equipment shall be submitted to The University prior to Functional Performance Tests.

E. Responsibilities of the various parties involved in the Commissioning process are defined in Section 20 08 00.

F. Refer to Attachments A, B, C, and D at the end of this Section for example forms that indicate level of documentation required for the Commissioning process.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.04 SUBMITTALS

A. Prefunctional Checklists, Prefunctional Tests, and Start-up documents are the normal procedure of ensuring that the mechanical, plumbing, and fire protection system components are properly installed.

B. The Subcontractor in cooperation with the A/E and Contractor shall develop Prefunctional Checklists and Prefunctional Tests during the Construction Phase.

C. Completeness of Prefunctional Checklists: This Section summarizes the minimum standard for systems and equipment checkout. A record of testing and acknowledgement that a procedure has been completed and that it checks out acceptably must be included in the Prefunctional Checklists. The Prefunctional Checklist shall identify in columnar format each device, location, test method, control sequence of operation reference, device code reported, and other data as appropriate.

D. Equipment Data Documentation: Provide completed, as-installed, specific product nameplate data, product numbers, serial numbers, etc. to fully define the asset for Owner's use in maintenance management and asset tracking. This data may be incorporated within the Equipment List/Matrix as described in Division 01 as a spreadsheet format or electronic database. In addition to specific manufacturer's name and specific product identifiers such as model number, serial numbers, date of manufacture, etc, the following information shall be included with the equipment data documentation:

   1. Capacity data: Where applicable, use equipment schedules on the Drawings as a guideline for fields to be used.

   2. Location identifier field for each of the three dimensions (Floor Level, X axis, and Y axis) using the Drawing column grids as the basis for location.

E. Submit the equipment data documentation with the draft Prefunctional Checklists to The University for approval. A/E and Owner will review the Prefunctional Checklists and request any additional information required to meet the Commissioning Plan criteria.

F. Written Certification: The Contractor shall certify that the installation, Start-up, Prefunctional Checklist, and initial operation of the system or component is in accordance with the Contract Documents, Commissioning Plan, and manufacturer's requirements, and that the system is ready for Functional Performance Tests. Any outstanding items or non-conformance shall be clearly indicated and highlighted on the Prefunctional Checklist and an action item shall have been initiated. Refer to Division 01 for specific details on non-conformance issues relating to Prefunctional Checklists.

G. Refer to Section 20 08 00 for additional documentation requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. The Prefunctional Checklist procedures described in this Section provide minimum guidelines for development of Prefunctional Checklists; Start-up procedures, and Prefunctional Tests. Contractor shall prepare the Prefunctional Checklists using these procedures and that of the manufacturer's and/or applicable codes and standards.

C. The Prefunctional Checklist form shall acknowledge that installation and Start-up procedures were successfully adhered to and completely performed and shall document relevant parameters (panel and equipment connections, measured values, ground faults, trip settings, etc.). When indicated as performing a checkout on multiple items or multiple procedure items, Prefunctional Checklist forms shall itemize each individual item.

2.02 TEST EQUIPMENT

A. Refer to Section 20 08 00 – HVAC/Plumbing/Fire Suppression System Commissioning.

PART 3 - EXECUTION

3.01 PREFUNCTIONAL CHECKLIST PROCEDURES

[Edit the following as appropriate for the Project:]

A. Valves:

1. Operate all manual and automatic valves through their full stoke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
2. Verify that actuators are properly installed with adequate clearance.
3. For automatic, pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.

B. Meters and Gauges:

1. Adjust faces of meters and gauges to proper angle for best visibility.
2. Clean windows of meters and gauges, including factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gauges that require temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure that threads are clean and that connection can be easily made.
3. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

C. Mechanical Identification:

1. Verify that all valve tags, piping, duct, and equipment labeling corresponds with the Drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
2. Adjusting: Relocate any mechanical identification device which has become visually blocked by Work of this Division or other Divisions.
3. Cleaning: Clean the face of identification devices and glass frames of valve charts.

D. Mechanical Insulation:

1. Examine all systems and equipment specified to be insulated.
2. Patch and repair all insulation that has been damaged after installation.
3. Ensure the integrity of the vapor barrier around all cold surfaces.

E. Fire Suppression Systems:

1. Additional procedures required for Testing and inspection of Fire Protection Systems are specified within individual Specification Sections. Testing of fire protection systems will generally be conducted by the Fire Protection Subcontractor with Contractor and Owner witnessing.
   a. Check operation prior to, during, and after a power outage to ensure required sequences and system restart.

2. Fire Protection Subcontractor shall submit forms to the Contractor for approval in concert with the appropriate mechanical system Prefunctional Checklist forms. All procedures and results shall be documented in the approved forms.

F. Piping:

1. The following applies to all installed piping systems including underground Site utilities. Responsibility for preparation of the Prefunctional Checklist and testing of the piping systems generally lies with the installing Subcontractor.

    a. Inspect all piping for proper installation, adequate support with appropriate vibration isolation where applicable, and adequate isolation valves for required service.

    b. Flush and treat all piping as appropriate to the application and clean all strainers.

    c. Ensure that adequate drainage is provided at low points and venting is provided at high points. Ensure that air is thoroughly removed from the system as applicable.

    d. Ensure that all piping is adequately supported and anchored to allow expansion. As applicable, bump across the line pumps and inspect for excessive pipe movement.

    e. Pressure and/or leak test all applicable systems in accordance with requirements in the applicable Specification Sections. Record pressure testing results and certification that piping meets the Specification and submit with the Prefunctional Checklist.

    f. Sterilize applicable piping systems as specified in the individual Specification Sections and as required by regulatory authorities. Record the results of sterilization and all parameters during this process and certify that the piping meets the Specification. Include results with Prefunctional Checklist.

    g. Submit test reports that document testing results and certification of results with the Prefunctional Checklist.

    h. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation. Document setting and actual trip points of all such controls.

    i. Set and adjust fill, pressure, or level controls to the required setting.

    j. Compare installation with mark-up as-built Drawings to ensure the drawing accuracy.

G. AC Motors:

1. The following applies to all AC motors serving equipment.

    a. Verify proper alignment, installation, and rotation.

    b. Measure the insulation resistance, phase balance, and resistance to ground. These measurements will generally be the responsibility of the mechanical Subcontractor who is connecting the motor. The motor manufacturer will be responsible to correct any deficiencies. When electrical Subcontractor wires to a single point of a packaged device that is shipped with multiple motors, electrical Subcontractor shall check all motors in the package.

    c. Verify that properly sized overloads are in place.

    d. Measure voltage available to all phases at the time of initial connection and after the motor has been placed in operation under load measure amps and RPM.

e. Record all motor nameplate data.

H. Variable Frequency Drives:

1. General: Provide the services of a factory-authorized service representative to inspect unit installation, provide Start-up service, and demonstrate and train Owner's personnel. Contractor shall also provide the services of an independent harmonic testing agency as specified.

2. Start-up Checks: Perform the following checks before Start-up and as specified in manufacturer's Start-up instructions:

3. Check unit for shipping damage.

4. Perform a point-to-point continuity test for all field-installed wiring interconnections. Verify terminations of field-installed wiring.

5. Check for proper torque on connections.

6. Verify use of shielded cable where specified and check that shields have been terminated properly.

7. Verify grounding.

8. Check motor nameplate against drive input rating.

9. Manually rotate motor shaft to ensure free rotation.

10. Check that motor leads are not grounded.

11. Verify that factory test documentation is on file at the Project Site.

12. Starting procedures: Follow the manufacturer’s printed procedures with the following as a minimum:

a. Ensure device and system that the drive is serving, is configured to withstand the device operation specified as follows.

1) Verify, test and document safety circuits are active. Tag the safety circuit termination at the VFD and safety device with the trip value.

2) Set all parameters required and verify all parameters have been programmed consistently for all VFDs on the project. Coordinate with the BAS relative to the interfaces (hard wired or software) and failure restart, status interfaces, acceleration rates, feedback, alarm states etc.

3) Adjust the minimum voltage adjustment to enable starting but not to draw excessive power at start.

4) Adjust the Volts/Hz adjustment to the proper setting.

5) Adjust the accel and decel rates to the specified times.

6) Adjust current limiting to coordinate with the overcorrect device and protect the motor.

7) Set the maximum and minimum speed points.

8) Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.

9) Identify any critical speeds to avoid and set these in the drive.

10) With the independent harmonic testing agency, check for acceptable voltage and current distortion on the power system. Record the input and output voltages and currents showing the harmonic content as a percentage of the base frequency.

11) Measure and record overall efficiency at 50 percent, 75 percent, and 100 percent.

12) Record the motor terminal voltage.

13) Check operation prior to, during, and after a power outage to ensure required sequences and system restart.

I. Laboratory Gas Piping Systems:

1. Contractor shall provide the services of a gas testing laboratory (GTL) to test the system in strict accordance with NFPA-45 and 99. GTL shall be routinely engaged in the certification of the type and extent of the systems installed for this Project. Testing shall include at a minimum: pressure, flow at outlets, purity, and cross contamination as applicable.

2. Clean and disinfect piping per Contract Documents.

3. Provide a draft test report for approval in concert with Prefunctional Checklist draft process. Provide full completed test reports at the completion of testing.

J. Laboratory Air Compressors and Vacuum Pumps:

1. General: Provide the services of a factory authorized representative to inspect equipment installation, Start-up equipment, and train Owner’s personnel.

2. Operate and adjust safety controls. Replace damaged and malfunctioning controls and equipment.

3. Refer to AC Motors in this Section.

4. Start-up Checks: Perform the following checks before Start-up:

a. Verify that pressure tests of piping systems are complete.

b. Check that laboratory air compressor inlets are properly located for clean air supply and that laboratory vacuum exhausts are properly located to prevent contamination of public spaces.

c. Check that laboratory air compressor inlet filters and piping and laboratory vacuum pump filters and discharge piping are clear.

d. Check for lubricating oil for lubricated-type equipment.

e. Check V-belts for proper tension. Record belt tension parameters.

f. Check equipment vibration control supports and flexible pipe connectors and that equipment is properly attached to substrate.

g. Check that safety (pressure relief) valves are properly set.

- h. Adjust vacuum relief valves.
- i. Drain laboratory air and vacuum receiver tanks.
- j. Check for proper seismic restraints.
- k. Check for adequate room ventilation.
- l. Check that all factory tests are filed at the Project Site.
- m. Check that all documentation required for O&M and Start-up are filed at the Project Site.

5. Starting Procedures: Follow the manufacturer’s printed procedures as a minimum:
    - a. Energize circuits.
    - b. Start and run equipment through complete sequence of operations. Check for lead-lag operation, compressor minimum run and off times, sequencing etc. per the Specification and manufacturer’s recommendations.
    - c. Check for excessive vibration and noise.
    - d. Check air and vacuum pressures.
    - e. Manually operate safety valves and vacuum relief valves.
    - f. Adjust operating controls including pressure and vacuum settings per direction of Owner.
    - g. Check operation prior to, during, and after a power outage to ensure required sequences and system restart.

K. High Purity Water System

1. General: Provide the services of a factory authorized representative to inspect equipment installation, Start-up equipment, and train The University’s personnel.
2. Start-up Checks: Perform the following checks before Start-up:
    - a. Ensure piping is properly installed, sterilized, and tested.
    - b. Fill brine tank.
    - c. Ensure three (3) valve bypass, pressure gauges, and sample valve are installed on the UV sterilizer and Pre and Final Filters.
    - d. Ensure isolation valves are installed throughout the system as required by the Specifications.
    - e. Ensure that proper power source is provided and connected to the UV sterilizer. Verify the BAS interface for on/off, high temperature alarm, and no flow alarm.
    - f. At the DI Columns, ensure that each can be isolated for service, that each column is properly secured to the frame, that the manual isolation valve is installed on the common discharge header, that the resistivity monitor is installed and connected to the BAS, and that the sample valve is provided.
    - g. Verify that storage tank fill and level controls are installed and functional.
3. Starting Procedures: Follow the manufacturer’s printed procedures as a minimum:

   a. Start-up and check out booster pumps.
   b. Run pretreatment through all regeneration and backwash cycles.
   c. Demonstrate that blending valve is operational.
   d. Test the storage tank make-up and fill and associated alarming function.
   e. Calibrate all sensors including resistivity meters.
   f. Run system through all modes of operation and ensure that the controls, alarms, and safeties are functional and properly adjusted.
   g. Perform bacteria and Total Organic Content test as per applicable Specification Section.
   h. Test operation of system prior to, during, and after power outage to ensure proper operation and system restart.

L. Storage Tanks:

   1. Inspect the tank for proper installation and support in conformance with the manufacturer’s recommendations.
   2. Verify that all required instrumentation is provided and installed in accordance with the Contract Documents.
   3. For pressurized tanks, pressure test the tanks per the requirements in the applicable Specification Section and per the ASME Code where applicable.
   4. Non-pressure Testing: Fill non-pressure water storage tanks to water operating level to ensure structural integrity and freedom from leaks. Hold water level for 2 hours with no drop in water level.
   5. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.
   6. Clean and disinfect water storage tanks for use with potable water systems as specified in the respective Section.
   7. Prepare and submit reports for all testing, purging, and disinfecting activities.
   8. Check that pressure relief valves have correct setting.
   9. Test operation of tank accessories and devices.
   10. Adjust vacuum relief valves.
   11. Manually operate relief valves.
   12. Adjust pressure and vacuum settings.

M. Water Heaters:

   1. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide Start-up service, and demonstrate and train Owner's personnel as specified below.
      a. Check for adequate steam supply and piping per manufacturer’s direction.

b. Check for leaks at piping connections.

c. Check that recirculation and control requirements are per manufacturer’s recommendations.

d. Check adequate condensate removal and venting of steam.

e. Verify that steam traps are working properly.

f. Verify that modulated steam is not being lifted.

g. Set and test relief valves and record test parameters.

h. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

i. Record all Start-up procedures and parameters in Prefunctional Checklists.

N. Compressed Air Systems:

1. General: Provide the services of a factory-authorized service representative or qualified technician to test and inspect unit installation, provide Start-up service, and to demonstrate and train Owner's personnel as specified below.

2. Refer to AC Motors in this Section.

3. Preparation: Perform the following final checks before Start-up.

4. Piping System Tests: Complete system test in accordance with the respective Section.

   a. Inspect the installation and access/clearance for service and maintenance to ensure it meets the Contract Document and manufacturer’s requirements.

   b. Check for leaks at piping connections.

   c. Check lubricating oil for lubricated-type equipment.

   d. Check V-belts for proper tension.

   e. Check that compressor inlet filters and piping are clear.

   f. Check equipment vibration-control supports and flexible pipe connectors and that equipment is properly attached to substrate.

   g. Check for proper seismic restraints.

   h. Check that safety valves have correct setting; greater than compressor discharge pressure, but less than the pressure rating of system components.

   i. Test operation of equipment safety controls and devices.

   j. Check water supply to water-cooled equipment.

   k. Check water supply to liquid-ring air compressors.

   l. Drain receiver tanks.

   m. Check for adequate room ventilation.

5. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:
    a. Energize circuits.
    b. Check for proper rotation of 3-phase motors.
    c. Start and run equipment through complete sequence of operations.
    d. Verify air dryer is hardwired interlocked to prevent the compressor from running unless the dryer is running.
    e. Check for excessive vibration and noise. Correct deficiencies.
    f. Check air pressures.
    g. Manually operate safety valves.
    h. Adjust operating controls including pressure settings.

O. Hydronic Piping:

1. Refer to Piping Section.
2. Prepare hydronic and test piping in accordance with applicable Specification Section and ASME B 31.9 and/or B 31.1.
3. Flush system with clean water. Clean strainers.
4. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.
5. Check expansion tanks to verify that tanks are not air bound and that the system is completely full of water.
6. Set automatic fill valves for required system pressure.
7. Check air vents at high points of systems and determine if air vents are installed and operating freely (automatic type) or to bleed air completely (manual type).
8. Set and coordinate automatic fill pressure and relief valve settings.
9. Steam and Condensate Piping:
10. Refer to Piping Section.
11. Prepare and test steam and condensate piping in accordance with applicable Section and ASME B 31.9 and or B31.1 as applicable.
12. Flush the system with clean water. Remove, clean, and replace strainer screens.
13. Gradually warm-up piping and connected equipment. Introduce steam to piping system by throttling valves.
14. Take precautions to prevent water hammer or slugging in piping.
15. Vent air and non-condensable gases from system.

16. Supervise condensate removal at system traps. Temporarily bypass traps, if required.
17. Verify complete condensate removal from piping and equipment and that traps are functioning properly.

P. Pumps:

1. Check suction line connections for tightness to avoid inducing air into the pump.
2. Clean and lubricate all bearings.
3. Refer to AC Motors in this Section.
4. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
5. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
6. Clean associated strainers.
7. Verify that OSHA approved coupling guards are in place.
8. Check that the proper overloads have been installed in the starter and that overloads are the correct size.
9. Verify that the integrity of the vibration isolation is maintained throughout the support and the piping connections.
10. Align pump within manufacturer’s recommended tolerances.
11. Ensure that all associated piping has been cleaned, tested and deareated.
12. Start the pump and check that all seal piping/installation is per manufacturer’s instructions.
13. Check the general mechanical operation of the pump and motor.
14. Verify that all thermometers and gauges are installed, are clean and undamaged, and are functional.
15. Verify that the check valve seal is appropriate for the application.
16. Check noise and vibration levels and ensure that they are within the manufacturer’s recommended tolerances.
17. Check that the NPSH is within the allowable parameters for the operating condition.
18. Steam To Hot Water Converters:
19. Verify clearances for maintenance.
20. Flush and clean converters upon completion of installation in accordance with manufacturer's Start-up instructions.
21. Hydrostatically test assembled converter and piping in accordance with applicable Sections of the ASME Boiler and Pressure Vessel Code.

22. Check that the heat exchanger is properly supported and restrained and that it is installed with sufficient slope to the condensate outlet.

23. Check for adequate steam removal. Verify that modulated steam is not being lifted.

24. Check that vents and vacuum breakers are installed as required by the Contract Documents and that they are clear.

25. Verify sequencing, stroke, and range of valves. Coordinate ranges with the Building Automation System (BAS).

26. Start-up converters in accordance with manufacturer's Start-up instructions. Verify high temperature cut out switch is set and hardwired interlocked to close all valves on a trip. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

27. Record all parameters (flow, temperatures, pressures, etc.) and tests and submit with Prefunctional Checklist **Test form.**

Q. Steam Condensate Pumps:

1. General: Start-up condensate pumping equipment in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements.

2. Check for free and adequate inlet flow of condensate. Validate that condensate pressure/temperature does not cause pump cavitation.

3. Check for adequate venting of the receiver.

4. Refer to AC Motors in this Section.

5. Set and test level controls and alarm contacts as applicable.

6. Validate lead/lag and back-up of pumps and control for multiple pump systems.

7. Validate that overflows are piped safely as applicable.

8. Factory-Fabricated Cooling Towers:

9. Cleaning: Clean inside of cooling tower thoroughly before filling for Start-up. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

10. Start-up: Comply with manufacturer's instructions for filling and Start-up of operation, including, but not limited to, the following:

11. Inspect the installation and access/clearance for service and maintenance to ensure it meets the Contract Documents and manufacturer’s requirements.

12. Check manufacturer’s required clearances for airflow.

13. Check that all required O&M documentation has been provided and that the documentation is filed at the Project Site.

14. Verify that fill is not damaged.

15. Check that the tower is installed level and plumb.

16. Verify that the tower is properly supported.

17. Check any vibration isolation and ensure that it is not compromised.
18. Verify lubrication of rotating parts; lubricate as needed.
19. Verify fan rotation direction.
20. Verify that motor amperage is in accordance with manufacturer's data. Verify that vibration and/or all required safety hardwired interlock are functioning correctly.
21. Refer to AC Motors of this Section.
22. Refer to Fans of this Section.
23. Check that make-up is of adequate capacity and properly protected from freezing.
24. Balance condenser water flow to each tower and to each inlet for multiple inlet towers.
25. Adjust water level control for proper operating level.
26. Ensure water outlet does not have entrained air.
27. Adjust temperature controls and verify operation.
28. Check sumps and basins to ensure they are clean and free of debris.

R. Terminal Units:

1. General: After construction and painting is completed, clean exposed surfaces of the terminal unit and vacuum clean terminal coils and inside of cabinets.
2. Retouch any marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
3. Ensure that the unit is properly supported.
4. Verify adequate access for maintenance.
5. Verify that the unit is installed per manufacturer’s instructions and details.
6. Install new filters for terminal units that require filters.
7. Open vents to ensure that the coil is properly vented.
8. Check that the unit is properly labeled and/or a ceiling marker has been provided for concealed terminal units.
9. Check power and control voltages.
10. Check for proper condensate drainage as applicable.
11. Check rotation of fan where applicable.
12. Check calibration and operation of the controlling elements.
13. Check control valves for required close off and fail position.
14. Temporary Closure: Verify terminal units which are not scheduled to operate are provided temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris unit is scheduled to operate.

15. Verify that thermostats or temperature sensors are in a proper location to adequately represent space temperature. Verify temperature sensors not scheduled to be installed are secured properly on the top of the unit

S. VAV Terminal Units:

1. General: After construction and painting is completed, clean exposed surfaces of terminal units and vacuum clean terminal coils and inside of cabinets.

2. Retouch any marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

3. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.

4. Verify that proper access has been provided to the airflow control devices and any heat exchange surfaces.

5. Ensure that the air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.

6. Check all dampers and linkages and wiring and tubing as applicable for tightness of the connections and terminations.

7. Refer to associated zone checkout procedures when applicable.

8. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable). Measure and record motor amperage and voltage.

9. Install new filters where required.

10. Calibrate and adjust the airflow control parameters. Set applicable minimum and maximum setpoints. Coordinate with the BAS provider as necessary to obtain required flow parameters.

11. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure that it closes and seals tightly. Ensure the coils are undamaged, combed, and vented.

12. Ensure any hydronic heating elements are properly vented and that any associated strainers are clean.

13. Verify the integrity of any vibration isolation devices.

14. Verify that thermostats or temperature sensors are in a proper location to adequately represent space temperature. Verify temperature sensors not scheduled to be installed are secured properly on the top of the unit

15. Temporary Closure: Verify VAV terminal units which are not scheduled to operate are provided temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris unit is scheduled to **operate**

T. Air Handling Units:

1. Manufacturer's Field Inspection or Custom Units: Arrange and pay for a factory-authorized service representative to inspect the field assembly of components and installation of custom air-handling units including piping, ductwork, and electrical connections.

2. Ensure that all O&M data for all components is provided and available at the Project Site.

3. Ensure that all access doors are provided and that they swing against pressure.
4. Check that all required service receptacles and light fixtures are installed and operating.
5. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Ensure that volatile irritants are contained and kept out of occupied spaces.
6. Vacuum clean the fan wheel, fan cabinet, and entering air face of coils.
7. Adjust and lubricate dampers and linkages for proper damper operation.
8. For field fabricated units, ensure the components are properly connected within acceptable tolerances.
9. Check that all sound attenuating devices are clean and properly installed.
10. Verify temperature sensing elements are secured properly with correct support devices as recommended by manufacturer.
11. Verify any high static cut out switches are properly installed with copper tubing, calibrated, tagged with trip set point, and wired.
12. Verify low temperature detection switches are hard wired interlocked to turn off fan and close OA damper.
13. Seal all penetrations air tight and ensure access doors seat tightly. Pressure tests the units to verify that they meet specified leakage.
14. Verify that the unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
15. Ensure vibration isolation integrity is maintained throughout the air handling unit installation and the connections to it.
16. Refer to AC Motors in this Section.
17. Refer to Fans in this Section.
18. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align belts, and install belt guards.
19. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
20. Comb coil fins.
21. Inspect coil piping connections and ensure that they are per the Contract Documents. Validate that all thermometers, pressure gauges, test ports, and balancing device connections are provided, accessible, and not plugged.
22. Install clean filters. Provide new filters at completion of Functional Performance Tests.
23. Ensure that condensate drains properly and that the trap is adequate.
24. Stroke all valves and dampers to ensure free and full travel.
25. Pressure test units as required in the air handling unit Specification.

26. Refer to Division 25, BAS Commissioning, for procedures on starting controls related to air handling units.

U. Fans – General Across Systems:

1. Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to inspect the field assembly of components and installation of fans including ductwork, and electrical connections.
2. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Ensure that volatile irritants are contained and kept out of occupied spaces.
3. Vacuum clean the fan wheel, fan cabinet, and entering air face of coils.
4. Adjust and lubricate dampers and linkages for proper damper operation.
5. Verify that the unit is secure on mountings and supporting devices and that connections for ductwork and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
6. Ensure that vibration isolation integrity is maintained with the fan installation and connections to the fan.
7. Refer to AC Motors in this Section.
8. Properly align and tension all belts. Record tensioning parameters in the Prefunctional Checklists.
9. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align belts, and install belt guards.
10. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
11. Stroke all dampers to ensure free and full travel.
12. Refer to Division 25, BAS Commissioning, for procedures on starting controls related to fans.

V. Energy Recovery Wheels:

1. Manufacturer's Start-up: Arrange and pay for a factory-authorized service representative to inspect the field assembly of components and installation of wheel, drive, controls, and electrical connections.
2. Start-up Checks: Perform the following checks before Start-up and as specified in manufacturer's Start-up instructions.
    a. Check for damage to the wheel and that media and ensure media is evenly/thoroughly impregnated.

    i. Ensure that the wheel rotates freely.

    j. Ensure that all drive components are correctly installed, aligned, and lubricated.

    k. Ensure that air seals are tight and properly installed and that purge angles are set per the manufacturer’s recommendations.

    l. Meet and coordinate with the BAS Provider to review the application for proper control of the wheel and interface of hardware.

m. Verify that all controls are in place and that they are properly interfaced.

n. Energize circuits:

1) Check belt installation, tension, and alignment.

2) Check for proper rotation in all modes of operation.

3) Start and run the wheel through complete sequence of operations.

4) Measure and record the sensible and latent recovery efficiency.

5) Measure and record air pressure drop.

6) Estimate purge volume.

7) Check all interfaces to the BAS.

8) Adjust operating controls.

9) Provide services of an independent testing agency to test the cross contamination. Document all procedures and results.

W. Air Cleaning:

1. Inspect installation and check for air leakage of unfiltered air while system is operating.

2. Check access for filter installation.

3. Check that filter efficiencies are per the Specifications.

4. Validate that airflow is adequately even across the face.

5. Provide new filters as required throughout construction and provide new filters at the completion of functional **testing.**

X. Metal Ductwork:

1. Inspect all ductwork for damage and dents and correct any deficiencies.

2. Check ductwork system to ensure that all required dampers, vanes, access doors, testing ports, and other appurtenances are required per the Contract Documents.

3. Check all penetrations through building elements and ensure tightness and integrity of fire ratings.

4. Leakage Tests: After each ductwork system that is constructed for ductwork pressure classification over 3 inches is completed, test for ductwork leakage in accordance with Section 23 31 00.

5. Clean ductwork internally of dust and debris, unit by unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

6. Strip protective paper from stainless steel ductwork surfaces and repair finish wherever the finish has been damaged.

7. Temporary Closure: At ends of ductwork which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until final ductwork connections are to be completed.

8. Check pressure class of ductwork against fan dead head to verify adequacy.

Y. Ductwork Accessories:

1. Inspect and operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

2. Develop a checkout sheet for all fire dampers. Physically inspect and operate every fire damper.

3. Install fusible links in fire dampers and adjust for proper action.

4. Label access doors in accordance with Contract Documents.

5. Fire Damper Testing: Coordinate with the local authority. For every fire damper, remove the fusible link and verify that the damper operates freely and closes tightly. Reinstall the fusible link.

6. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's **touch-up paint.**

Z. Building Automation System:

1. Start-Up: Refer to Division 25, BAS Commissioning. This Division requires the manufacturer’s authorized representative to Start-up, test, adjust, and calibrate DDC control systems and to demonstrate compliance with Contract Document requirements. This will include verification of sequences, normal and emergency operations, calibration, interfaces, and interlocks, etc.

2. Inspect installation for conformance to manufacturer’s requirements.

3. Verify controls for seasonal isolation and for modulation.

4. Verify discharge high limit controls are installed and functioning. Record limit setpoint and operating parameters.

5. Plate And Frame Heat Exchangers:

6. Inspect installation for conformance to the manufacturer’s requirements.

7. Check piping connections to ensure that connections are per the Contract Documents.

8. Verify that all labeling is affixed and that all appurtenances are install and accessible.

9. Confirm that all required O&M documentation is at the Project Site.

10. Verify that plates are tight and that bolts are evenly torqued.

11. Check inlet and outlet terminations to verify that piping is properly connected.

3.02 ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in the Specification Sections applicable to the systems being tested. Unless indicated otherwise, acceptance criteria will be specified with the individual system, equipment, component, or device.

3.03 TRAINING

A. Training requirements are specified in Division 01 Specifications and in Section 20 08 00 – HVAC/Plumbing/Fire Suppression System Commissioning.

B. Request for Start-up/FUNCTIONAL PERFORMANCE TEST

(Check applicable request below)
Request for Initial Startup ______ Request for Owner's Demonstration ______

Project: ______________________________________ **Project** #:_____________________

Identification of Equipment or System: ____

Location of Equipment or System: ____

Specification Section: ____________________ Detail/Drawing Number: _______________

Manufacturer / Supplier: ____

This Date: __________________ Inspection Requested for (Date): __________________

CONTRACTOR'S CERTIFICATION OF PERFORMANCE:
I hereby certify that the above described equipment or system, has been energized, operated, adjusted, and balanced in accordance with the requirements of the Contract Documents and the manufacturer's recommendations for a sufficient period to confirm that operation complies in all respects with the Contract Requirements.

___________________________ ___________________________ ___________
Signature Printed Name Date

Installing Subcontractor:

___________________________ ___________________________ ___________
Signature Printed Name Date

Manufacturer's Representative: I hereby certify that I have been personally and actively involved with energizing, operational checkout, adjustments, and balancing of the above described equipment or system; and that such has been accomplished in accordance with the manufacturer's recommendations and is operating correctly.

___________________________ ___________________________ ___________
Signature Printed Name Date

CONFIRMATION or COMMENTS from MDACC:

____

Results of Test Acceptable? ____YES ____NO Re-Test Required? ____YES ____NO

Punch List: ____Attached ____To Follow ____N/A

System Acceptable for "User Training"? ____Yes ____No

___________________________ ___________________________ ___________
Signature(s) – MDACC –Facility Manager Printed Name(s) – MDACC Date

___________________________ ___________________________ ___________
Signature(s) – MDACC – Project Manager Printed Name(s) – MDACC Date

EXAMPLE - PREFUNCTIONAL CHECKLIST
HVAC Pumps

Project: ______________________________________ **Project** #:_____________________

Identification of Equipment or System: ____

Location of Equipment or System: ____

Specification Section: ____________________ Detail/Drawing Number: _______________

Manufacturer / Supplier: ____

This Date: __________________ Inspection Requested for (Date): __________________

PREFUNCTIONAL CHECKLIST NUMBER: ___________

Components Included:

___ Valves, ___ Gauges, ___ Strainer, ___Vibration isolators, ___Base

Associated Prefunctional Checklists:

___Piping, ___Tubing, ___Other________________

1. General:

   a. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

   b. ___ Deficiency Form attached.

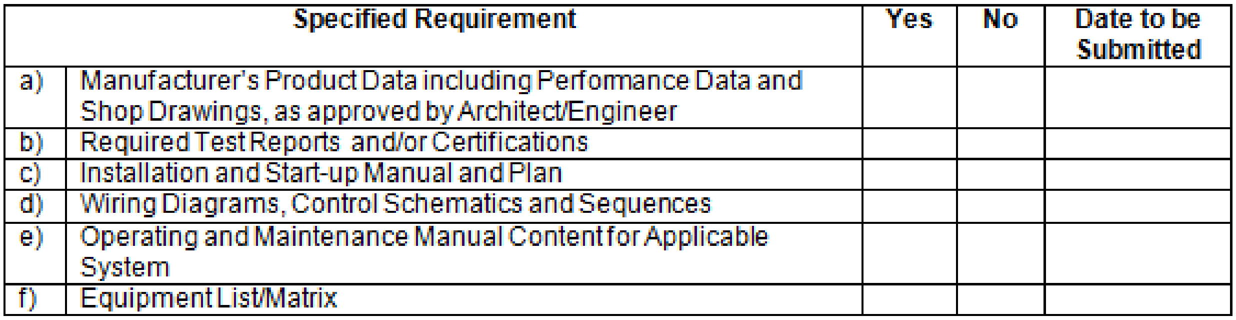
   c. This Prefunctional Checklist does not take the place of the manufacturer’s recommended checkout and start-up procedures or report.

   d. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be responsible to ensure that their subcontractors complete and check off their Checklist items.

   e. Prefunctional Checklist items shall be completed as part of start-up & initial checkout, preparatory to functional testing.

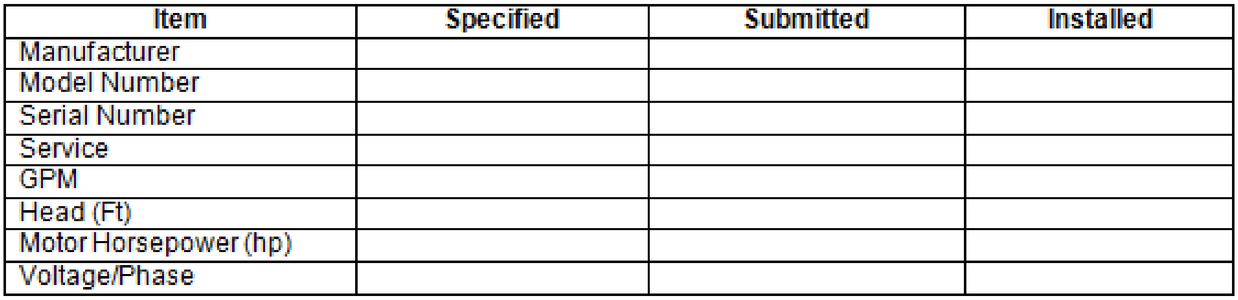
Contractor/Entity	Company	Abbreviation
M.D. Anderson Staff		MDACC
Architect/Engineer		A/E
General Contractor / Construction Manager		GC
Mechanical Contractor		MC
Electrical Contractor		EC
Building Automation System Provider		BAS
Test, Adjust, and Balance Firm		TAB
Commissioning Consultant		CA

2. Requested Documentation Submitted:



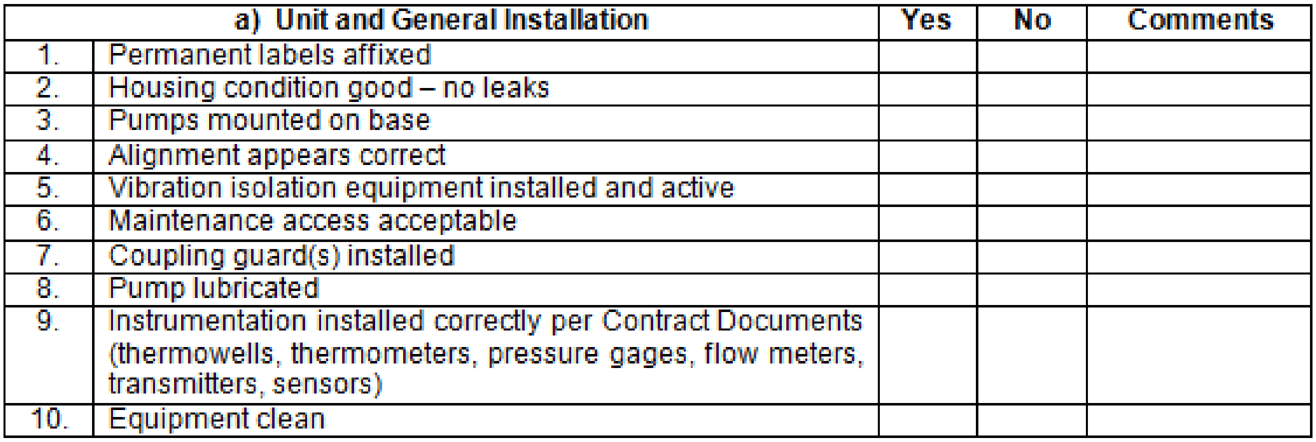
	Specified Requirement	Yes	No	Date to be Submitted
a)	Manufacturer's Product Data including Performance Data and Shop Drawings, as approved by Architect/Engineer			
b)	Required Test Reports and/or Certifications			
c)	Installation and Start-up Manual and Plan			
d)	Wiring Diagrams, Control Schematics and Sequences			
e)	Operating and Maintenance Manual Content for Applicable System			
f)	Equipment List/Matrix			

3. Equipment Verification:

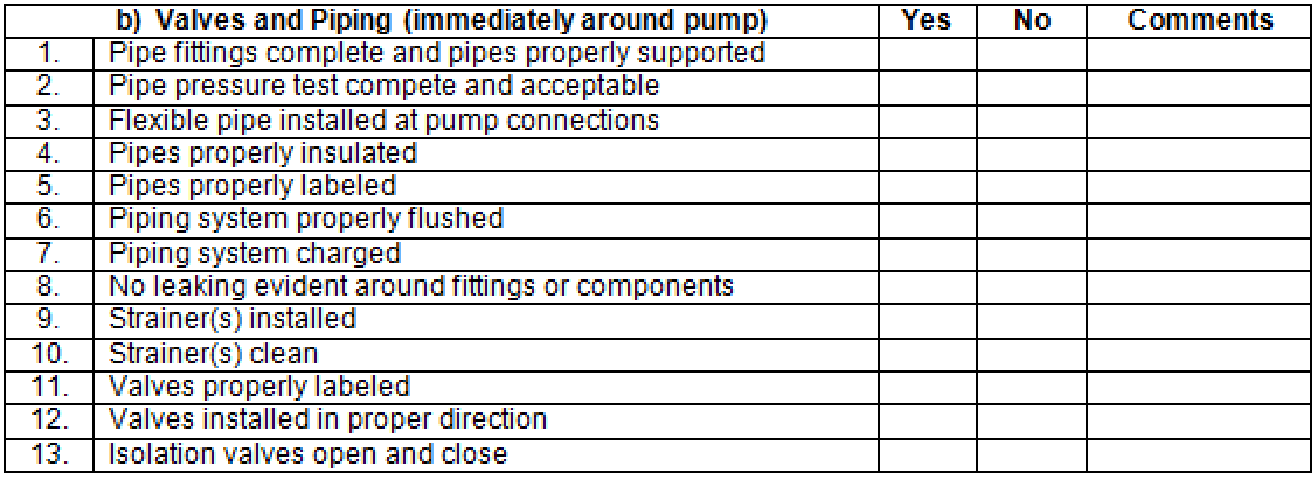


Item	Specified	Submitted	Installed
Manufacturer			
Model Number			
Serial Number			
Service			
GPM			
Head (Ft)			
Motor Horsepower (hp)			
Voltage/Phase			

4. Installation Checks:



a) Unit and General Installation		Yes	No	Comments
1.	Permanent labels affixed			
2.	Housing condition good – no leaks			
3.	Pumps mounted on base			
4.	Alignment appears correct			
5.	Vibration isolation equipment installed and active			
6.	Maintenance access acceptable			
7.	Coupling guard(s) installed			
8.	Pump lubricated			
9.	Instrumentation installed correctly per Contract Documents (thermowells, thermometers, pressure gages, flow meters, transmitters, sensors)			
10.	Equipment clean			



b) Valves and Piping (immediately around pump)		Yes	No	Comments
1.	Pipe fittings complete and pipes properly supported			
2.	Pipe pressure test compete and acceptable			
3.	Flexible pipe installed at pump connections			
4.	Pipes properly insulated			
5.	Pipes properly labeled			
6.	Piping system properly flushed			
7.	Piping system charged			
8.	No leaking evident around fittings or components			
9.	Strainer(s) installed			
10.	Strainer(s) clean			
11.	Valves properly labeled			
12.	Valves installed in proper direction			
13.	Isolation valves open and close			

c) Electrical and Controls		Yes	No	Comments
1.	HOA switch installed and functioning			
2.	Panel power source identified			
3.	Panel labeled with permanent label			
4.	Power disconnect in place and labeled			
5.	Low voltage wiring in separate conduit as 120 vac			
6.	120 vac lightning protection installed			
7.	Low voltage lightning protection installed (underground only)			
8.	Pneumatic devices separated from controller and electronics			
9.	End-of-line devices labeled and wiring tagged per Contract Documents			
10.	Panel devices labeled and wiring tagged per Contract Documents			
11.	I/O devices labeled and wiring tagged per Contract Documents			
12.	Digital inputs and outputs operational			
13.	Controller drawing and point summary log in panel			
14.	All electric connections tight			
15.	Proper grounding installed for components and unit			
16.	Safeties in place and operable			
17.	Starter overload breakers installed and correct size			
18.	Sensors calibrated (see below)			
19.	Control system interlocks hooked up and functional			
20.	All control devices, pneumatic tubing and wiring complete			

d) Variable Frequency Drive		Yes	No	Comments
1.	VFD Prefunctional Checklist complete and approved			

e) Final		Yes	No	Comments
1.	Start-up report completed and attached with this Prefunctional Checklist			
2.	Safeties and safe operating ranges for this equipment have been reviewed and accepted			
3.	Sequence of operation adequately indicates all information			
4.	System is ready for Functional Performance Test			

5. Operational Checks:

a.These checks supplement the manufacturer's list. This is not the Functional Performance Test.

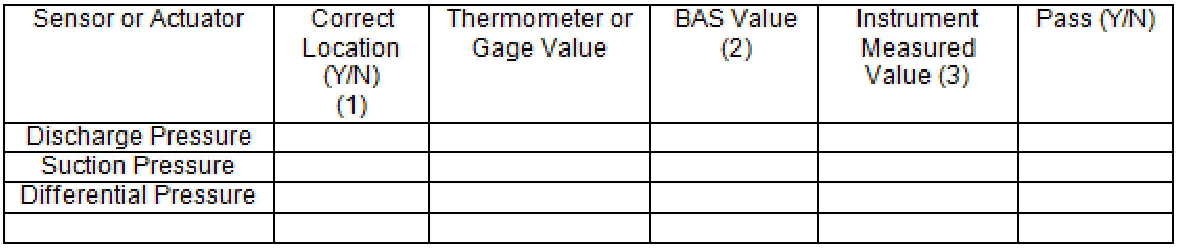
Operational Checks		Yes	No	Comments
1.	Pump(s) rotation correct			
2.	Pump Phase Checks (%Imbalance = 100 x (avg. – lowest) / avg.). Imbalance less than 2%?			
3.	All pumps running less than maximum FL amps			
4.	Pump noise and vibration acceptable			
5.	Cavitation exists			
6.	Valves stroke fully and easily			
7.	Specified sequences of operation and operating schedules have been implemented with all variations documented			
8.	Specified point-to-point checks have been completed and documentation record submitted for this system			
9.	Record full load running amps for each pump. Pump No. _____: ______rated FL amps x _______srvc factor = ________ (Max amps) Pump No. _____: ______rated FL amps x _______srvc factor = ________ (Max amps) Pump No. _____: ______rated FL amps x _______srvc factor = ________ (Max amps) Pump No. _____: ______rated FL amps x _______srvc factor = ________ (Max amps) Pump No. _____: ______rated FL amps x _______srvc factor = ________ (Max amps) Pump No. _____: ______rated FL amps x _______srvc factor = ________ (Max amps)			

6. Sensor and/or Actuator Calibration:

a. All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.

b. All test instruments have had a certified calibration within the last 12-months: Y / N

c. Sensor/Actuator Verification Table



Sensor or Actuator	Correct Location (Y/N) (1)	Thermometer or Gage Value	BAS Value (2)	Instrument Measured Value (3)	Pass (Y/N)
Discharge Pressure					
Suction Pressure					
Differential Pressure					

1) Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.
2) BAS is the Building Automation System. Instrument = testing instrument.
3) 3. All sensors are calibrated within required tolerances ___ YES ___ NO

FINAL SIGN-OFF

Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.

General Contractor:	Print Name:
	Signature:
	Title:
	Date:
Mechanical Subcontractor	Print Name:
	Signature:
	Title:
	Date:
Other Subcontractor:	Print Name:
	Signature:
	Title:
	Date:

Prefunctional Checklist received and reviewed for completeness by MDACC representatives.   Functional Performance Test can proceed.

MDACC:	Print Name:
	Signature:
	Title:
	Date:
MDACC:	Print Name:
	Signature:
	Title:
	Date:

EXAMPLE - PREFUNCTIONAL CHECKLIST

Air Handling Units - Modular

Project: ______________________________________ **Project** #:_____________________

Identification of Equipment or System: ____

Location of Equipment or System: ____

Specification Section: ____________________ Detail/Drawing Number: _______________

Manufacturer / Supplier: ____

This Date: __________________ Inspection Requested for (Date): __________________

PREFUNCTIONAL CHECKLIST NUMBER: ___________

Components Included:

___ Supply Fan, ___ Return Fan, ___ Cooling Coil(s), ___Valves, ___Control Dampers

Associated Prefunctional Checklists:

___Chilled Water Piping, ___Hot Water Piping, ___Exhaust Fans, ___Terminal Units, ___VFD, ___Smoke Dampers, ___Fire Dampers, ___Other________________

7. 1. General:

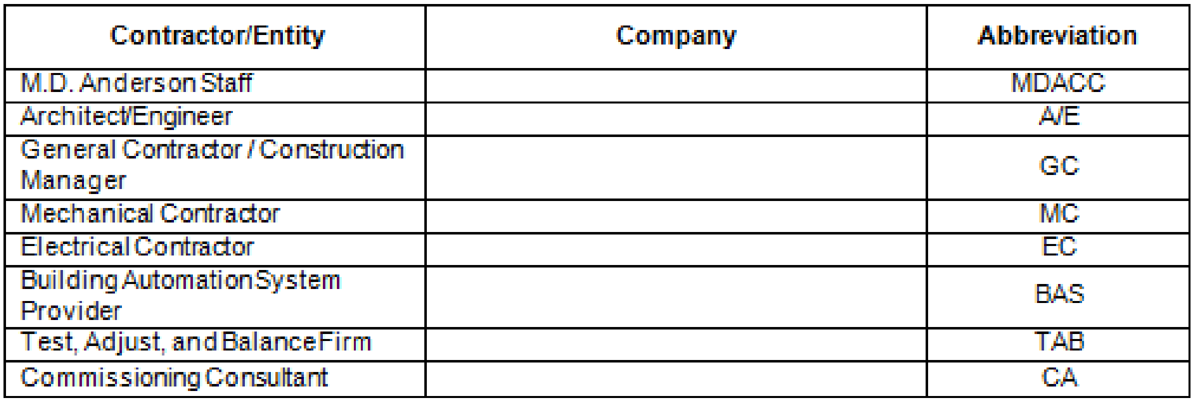
a. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

b. ___Deficiency Form attached.

c. This Prefunctional Checklist does not take the place of the manufacturer’s recommended checkout and start-up procedures or report.

d. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be responsible to ensure that their subcontractors complete and check off their Checklist items.

e. Prefunctional Checklist items shall be completed as part of start-up & initial checkout, preparatory to functional testing.



Contractor/Entity	Company	Abbreviation
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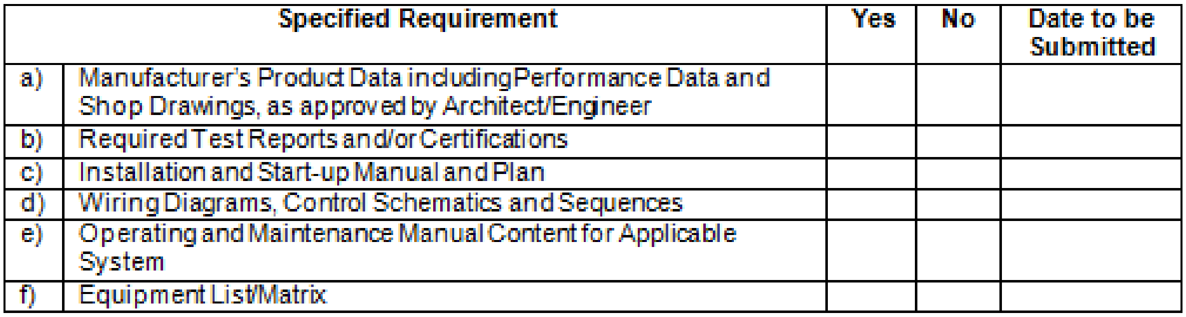
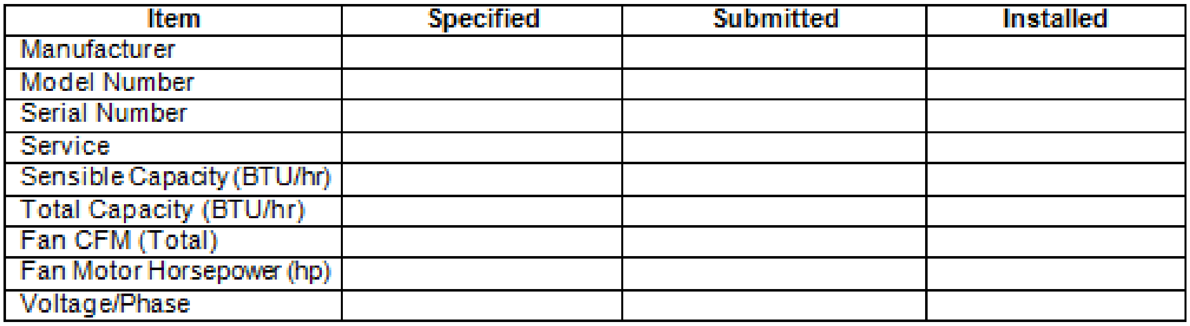
General Contractor / Construction Manager		GC
Mechanical Contractor		MC
Electrical Contractor		EC
Building Automation System Provider		BAS
Test, Adjust, and Balance Firm		TAB
Commissioning Consultant		CA

2. Requested Documentation Submitted



Specified Requirement		Yes	No	Date to be Submitted
a)	Manufacturer's Product Data including Performance Data and Shop Drawings, as approved by Architect/Engineer			
b)	Required Test Reports and/or Certifications			
c)	Installation and Start-up Manual and Plan			
d)	Wiring Diagrams, Control Schematics and Sequences			
e)	Operating and Maintenance Manual Content for Applicable System			
f)	Equipment List/Matrix			

3. Equipment Verification



Item	Specified	Submitted	Installed
Manufacturer			
Model Number			
Serial Number			
Service			
Sensible Capacity (BTU/hr)			
Total Capacity (BTU/hr)			
Fan CFM (Total)			
Fan Motor Horsepower (hp)			
Voltage/Phase			

4. Installation Checks

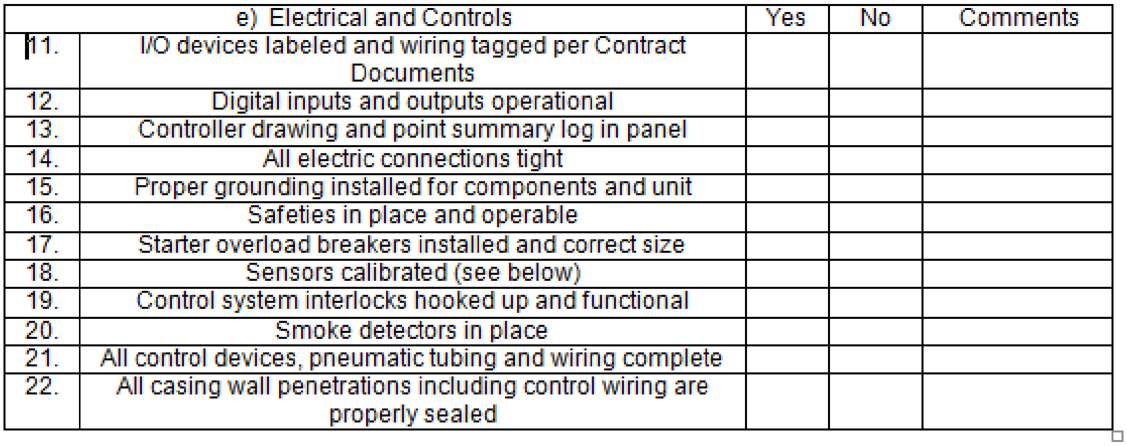
a) Unit and General Installation		Yes	No	Comments
1.	Permanent labels affixed			
2.	Casing condition good – no dents, leaks; door gaskets installed			
3.	Access doors close tightly – no apparent leaks			
4.	Flexible duct between unit and rigid duct tight; in good condition			
5.	Vibration isolation equipment installed and active			
6.	Maintenance access acceptable			
7.	Thermal insulation installed properly			
8.	Instrumentation installed correctly per Contract Documents (thermowells, thermometers, pressure gages, flow meters, transmitters, sensors)			
9.	Equipment clean			
10.	Filters clean with correct efficiency or MERV installed			
11.	Filter frame housing installation allows for easy filter replacement			
12.	Filter pressure differential measuring device installed and functional (magnahelic etc.)			
13.	Electronic filtration installed			
14.	Electronic filtration operational			

b) Valves, Piping, and Coils		Yes	No	Comments
1.	Pipe fittings complete and pipes properly supported			
2.	Pipes properly labeled			
3.	Pipes properly insulated			
4.	Piping system properly flushed			
5.	Piping system charged			
6.	No leaking evident around fittings or components			
7.	Coils are clean, fins are in good condition			
8.	Condensate drain pan(s) installed, clean, sloped properly			
9.	Condensate drain line(s) installed and supported correctly			
10.	Control valve and isolation valves installed			
11.	Valves properly labeled			
12.	Valves installed in proper direction			
13.	Isolation valves open and close			
14.	Outside air (OA) temperature, mixed air temperature, supply air temperature, return air temperature, chilled water supply/return sensors properly located and secure (related OA temperature sensor shielded)			
15.	Sensors calibrated (see calibration section below)			
16.	Pressure/temperature plugs and isolation valves installed per Contract Documents			

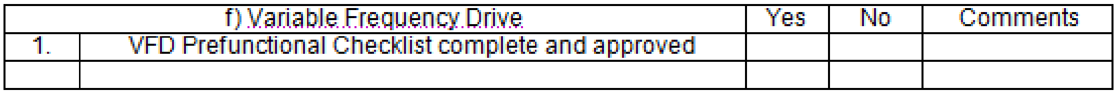
c) Fans and Dampers		Yes	No	Comments
1.	Supply fan and motor alignment correct			
2.	Supply fan belt tension and condition good			
3.	Supply fan protective shrouds for belts in place and secure			
4.	Supply fan area clean			
5.	Supply fan and motor lube lines installed and lubed			
6.	Return fan and motor alignment correct			
7.	Return fan belt tension and condition good			
8.	Return fan protective shrouds for belts in place and secure			
9.	Return fan area clean			
10.	Return fan and motor lube lines installed and lubed			
11.	Exhaust fan Checklists for service area complete			
12.	Smoke and fire dampers installed properly per Contract Documents (proper location, access doors, appropriate ratings verified)			
13.	All isolation and smoke dampers close and seal properly			
14.	All dampers (outside air, return air, supply air) stroke fully without binding			
15.	All damper linkages have minimum play			

d) Duct		Yes	No	Comments
1.	Sound attenuators installed			
2.	Duct joint sealant properly installed			
3.	No apparent severe duct restrictions			
4.	Turning vanes in square elbows as per Contract Documents			
5.	Outside air intakes located away from pollutant sources and exhaust outlets			
6.	Pressure leakage tests completed			
7.	Branch duct control dampers operable			
8.	Ducts cleaned as per Contract documents			
9.	Terminal units installed, Checklist complete			
10.	Balancing dampers installed per Contract Documents and TAB Firm's direction			
11.	Supply and return air devices installed			

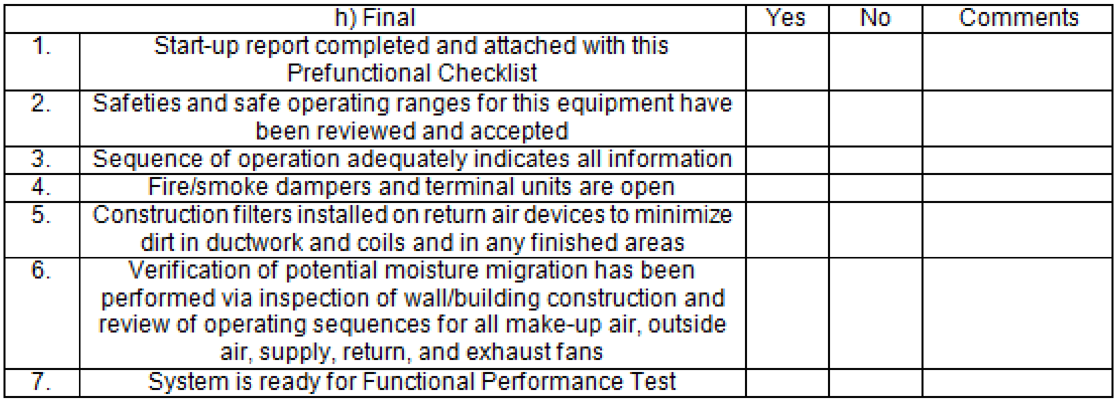
e) Electrical and Controls		Yes	No	Comments
1.	HOA switch installed and functioning			
2.	Panel power source identified			
3.	Panel labeled with permanent label			
4.	Power disconnect in place and labeled			
5.	Low voltage wiring in separate conduit as 120 vac			
6.	120 vac lightning protection installed			
7.	Low voltage lightning protection installed (underground only)			
8.	Pneumatic devices separated from controller and electronics			
9.	End-of-line devices labeled and wiring tagged per Contract Documents			
10.	Panel devices labeled and wiring tagged per Contract			



e) Electrical and Controls		Yes	No	Comments
11.	I/O devices labeled and wiring tagged per Contract Documents			
12.	Digital inputs and outputs operational			
13.	Controller drawing and point summary log in panel			
14.	All electric connections tight			
15.	Proper grounding installed for components and unit			
16.	Safeties in place and operable			
17.	Starter overload breakers installed and correct size			
18.	Sensors calibrated (see below)			
19.	Control system interlocks hooked up and functional			
20.	Smoke detectors in place			
21.	All control devices, pneumatic tubing and wiring complete			
22.	All casing wall penetrations including control wiring are properly sealed			



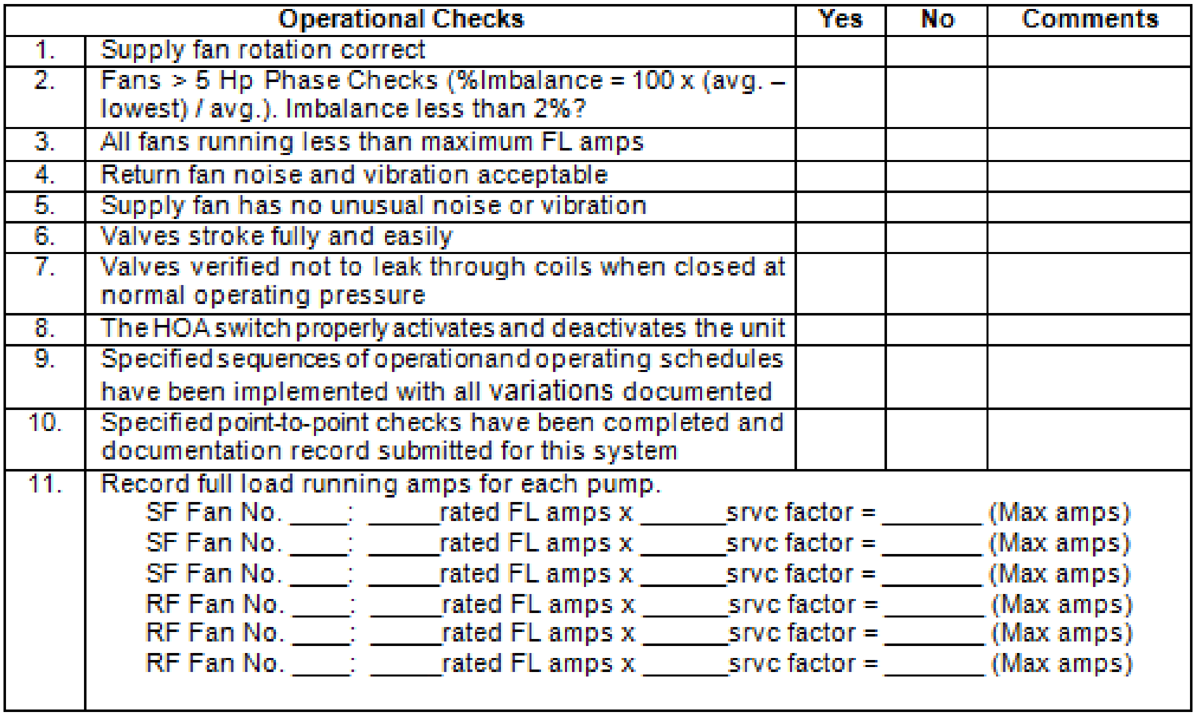
f) Variable Frequency Drive		Yes	No	Comments
1.	VFD Prefunctional Checklist complete and approved			



h) Final		Yes	No	Comments
1.	Start-up report completed and attached with this Prefunctional Checklist			
2.	Safeties and safe operating ranges for this equipment have been reviewed and accepted			
3.	Sequence of operation adequately indicates all information			
4.	Fire/smoke dampers and terminal units are open			
5.	Construction filters installed on return air devices to minimize dirt in ductwork and coils and in any finished areas			
6.	Verification of potential moisture migration has been performed via inspection of wall/building construction and review of operating sequences for all make-up air, outside air, supply, return, and exhaust fans			
7.	System is ready for Functional Performance Test			

5. Operational Checks:

   a. These checks supplement the manufacturer's list. This is not the Functional Performance Test.



	Operational Checks	Yes	No	Comments
1.	Supply fan rotation correct			
2.	Fans > 5 Hp Phase Checks (%Imbalance = 100 x (avg. – lowest) / avg.). Imbalance less than 2%?			
3.	All fans running less than maximum FL amps			
4.	Return fan noise and vibration acceptable			
5.	Supply fan has no unusual noise or vibration			
6.	Valves stroke fully and easily			
7.	Valves verified not to leak through coils when closed at normal operating pressure			
8.	The HOA switch properly activates and deactivates the unit			
9.	Specified sequences of operation and operating schedules have been implemented with all variations documented			
10.	Specified point-to-point checks have been completed and documentation record submitted for this system			
11.	Record full load running amps for each pump. SF Fan No. ____: _____rated FL amps x ______srvc factor = _______ (Max amps) SF Fan No. ____: _____rated FL amps x ______srvc factor = _______ (Max amps) SF Fan No. ____: _____rated FL amps x ______srvc factor = _______ (Max amps) RF Fan No. ____: _____rated FL amps x ______srvc factor = _______ (Max amps) RF Fan No. ____: _____rated FL amps x ______srvc factor = _______ (Max amps) RF Fan No. ____: _____rated FL amps x ______srvc factor = _______ (Max amps)			

6. Sensor and/or Actuator Calibration:

   a. All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.

   b. All test instruments have had a certified calibration within the last 12-months: Y / N

   c. Sensor/Actuator Verification Table (AHU in Operation)

Sensor or Actuator	Correct Location (Y/N) (1)	Thermometer or Gage Value	BAS Value (2)	Instrument Measured Value (3)	Pass (Y/N)
Supply air discharge					
Return air					
Outside air					
CHWR (at AHU)					
CHWS (at AHU)					
Duct SP (at SA discharge)					
CHW Control Valve Position					
HWR (at AHU)					
HWS (at AHU)					
HW Control Valve Position					

1. Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.
2. BAS is the Building Automation System. Instrument = testing instrument.
3. All sensors are calibrated within required tolerances ___ YES ___ NO

FINAL SIGN-OFF

Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.

General Contractor: Print Name:

Signature:

Title:

Date:

Mechanical Subcontractor Print Name:

Signature:

Title:

Date:

Other Subcontractor: Print Name:

Signature:

Title:

Date:

Prefunctional Checklist received and reviewed for completeness by MDACC representatives. Functional Performance Test can proceed.

MDACC: Print Name:

Signature:

Title:

Date:

MDACC: Print Name:

Signature:

Title:

Date:

EXAMPLE - PREFUNCTIONAL CHECKLIST

Terminal Units

Project: ____________________________________ **Project** #:____________________

Identification of Equipment or System: ____

Location of Equipment or System: ____

Specification Section: ___________________ Detail/Drawing Number: ______________

Manufacturer / Supplier: ____

This Date: _________________ Inspection Requested for (Date): _________________

PREFUNCTIONAL CHECKLIST NUMBER: __________

Components Included:

___ Damper, ___ Temperature Sensor, ___ Heating Coil, ___Fan

Associated Prefunctional Checklists:

___AHU- ______, ___Other________________

1.General:

a. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

b. ___Deficiency Form attached.

c. This Prefunctional Checklist does not take the place of the manufacturer's recommended checkout and start-up procedures or report.

d. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be responsible to ensure that their subcontractors complete and check off their Checklist items.

e. Prefunctional Checklist items shall be completed as part of start-up & initial checkout, preparatory to functional testing.

Contractor/Entity	Company	Abbreviation
M.D. Anderson Staff		MDACC
Architect/Engineer		A/E
General Contractor / Construction Manager		GC
Mechanical Contractor		MC
Electrical Contractor		EC
Building Automation System Provider		BAS
Test, Adjust, and Balance Firm		TAB
Commissioning Consultant		CA

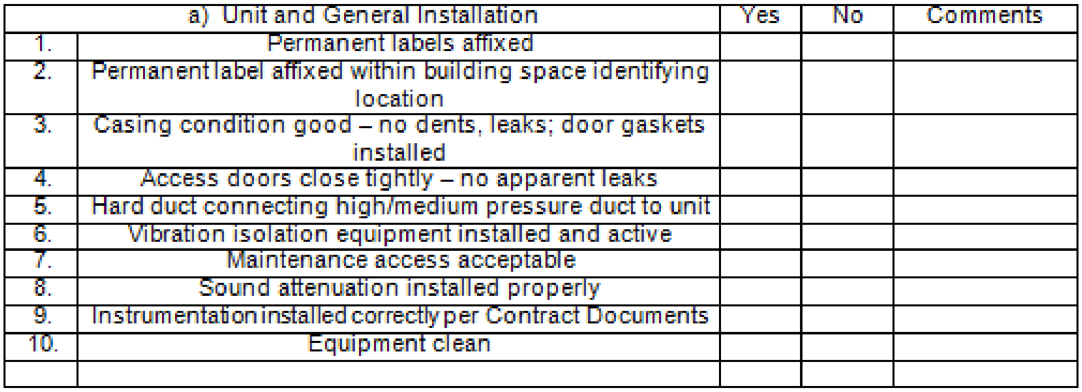
2. Requested Documentation Submitted

Specified Requirement		Yes	No	Date to be Submitted
a)	Manufacturer's Product Data including Performance Data and Shop Drawings, as approved by Architect/Engineer			
b)	Required Test Reports and/or Certifications			
c)	Installation and Start-up Manual and Plan			
d)	Wiring Diagrams, Control Schematics and Sequences			
e)	Operating and Maintenance Manual Content for Applicable System			
f)	Equipment List/Matrix			

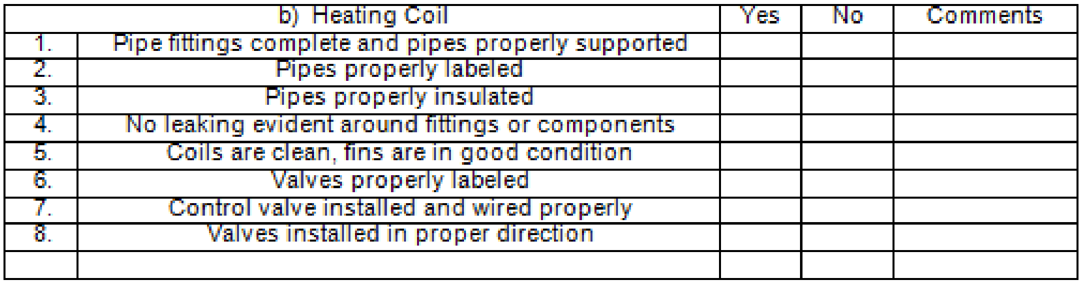
3. Equipment Verification

Item	Specified	Submitted	Installed
Manufacturer			
Model Number			
Serial Number			
Service			
Capacity (CFM)			
Maximum CFM			
Minimum CFM			
Fan Motor Horsepower (hp)			
Fan Voltage/Phase			
Electric Heat (kW) if applicable			

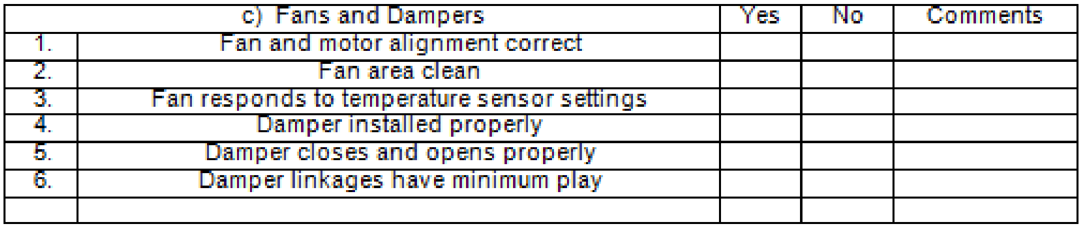
4. Installation Checks



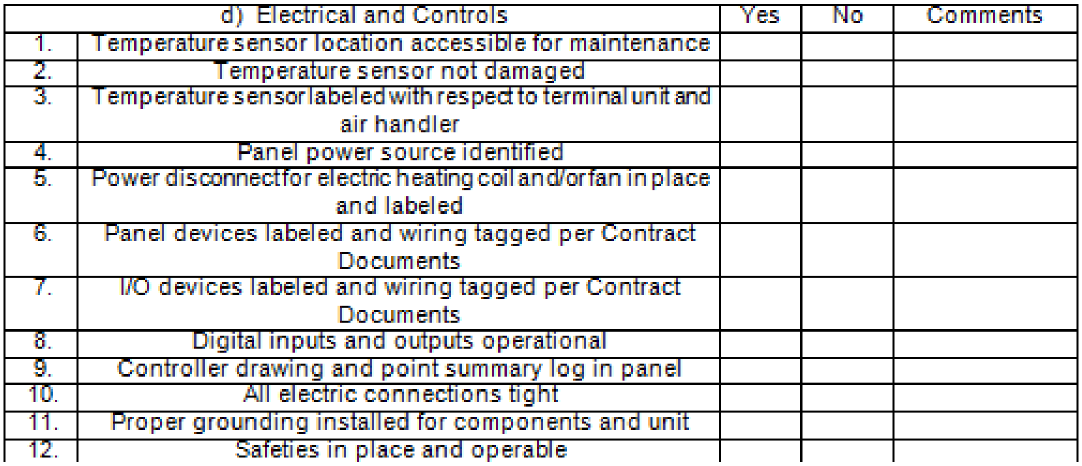
a) Unit and General Installation		Yes	No	Comments
1.	Permanent labels affixed			
2.	Permanent label affixed within building space identifying location			
3.	Casing condition good – no dents, leaks; door gaskets installed			
4.	Access doors close tightly – no apparent leaks			
5.	Hard duct connecting high/medium pressure duct to unit			
6.	Vibration isolation equipment installed and active			
7.	Maintenance access acceptable			
8.	Sound attenuation installed properly			
9.	Instrumentation installed correctly per Contract Documents			
10.	Equipment clean			



b) Heating Coil		Yes	No	Comments
1.	Pipe fittings complete and pipes properly supported			
2.	Pipes properly labeled			
3.	Pipes properly insulated			
4.	No leaking evident around fittings or components			
5.	Coils are clean, fins are in good condition			
6.	Valves properly labeled			
7.	Control valve installed and wired properly			
8.	Valves installed in proper direction			



c) Fans and Dampers		Yes	No	Comments
1.	Fan and motor alignment correct			
2.	Fan area clean			
3.	Fan responds to temperature sensor settings			
4.	Damper installed properly			
5.	Damper closes and opens properly			
6.	Damper linkages have minimum play			



d) Electrical and Controls		Yes	No	Comments
1.	Temperature sensor location accessible for maintenance			
2.	Temperature sensor not damaged			
3.	Temperature sensor labeled with respect to terminal unit and air handler			
4.	Panel power source identified			
5.	Power disconnect for electric heating coil and/or fan in place and labeled			
6.	Panel devices labeled and wiring tagged per Contract Documents			
7.	I/O devices labeled and wiring tagged per Contract Documents			
8.	Digital inputs and outputs operational			
9.	Controller drawing and point summary log in panel			
10.	All electric connections tight			
11.	Proper grounding installed for components and unit			
12.	Safeties in place and operable			

13.	Sensors calibrated (see below)			
14.	Control system interlocks hooked up and functional			
15.	All control devices and wiring complete			
16.	All control devices, pneumatic tubing and wiring complete			

f) Variable Frequency Drive		Yes	No	Comments
1.	VFD Prefunctional Checklist complete and approved			

h) Final		Yes	No	Comments
1.	Start-up report completed and attached with this Prefunctional Checklist			
2.	Safeties and safe operating ranges for this equipment have been reviewed and accepted			
3.	Sequence of operation adequately indicates all information			
4.	Terminal unit damper open			
5.	System is ready for Functional Performance Test			

5.Operational Checks

a. These checkes supplement the maufacturer's list. This is not the Functional Performance Test.

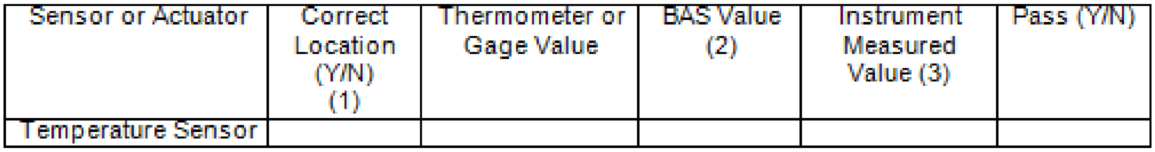
Operational Checks		Yes	No	Comments
1.	Acuated damper(s) responds to sensor temperature settings			
	Fan rotation correct			
2.	Record full load running amps for fan:			
	Fan No. ____: _____rated FL amps x ______srvc factor = ________ (Max amps)			
3.	Fan running less than maximum FL amps			
4.	Fan noise and vibration acceptable			
5.	Fan responds to temperature sensor settings			
6.	Heating coil responds to temperature sensor settings			
8.	Disconnect switch properly activates and deactivates the heating coil			
9.	Specified sequences of operation and operating schedules have been implemented with all variations documented			
10.	Specified point-to-point checks have been completed and documentation record submitted for this system			

6.Sensor and/or Actuator Calibration:

All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.

B .All test instruments have had a certified calibration within the last 12-months: Y / N

c. Sensor/Actuator Verification Table

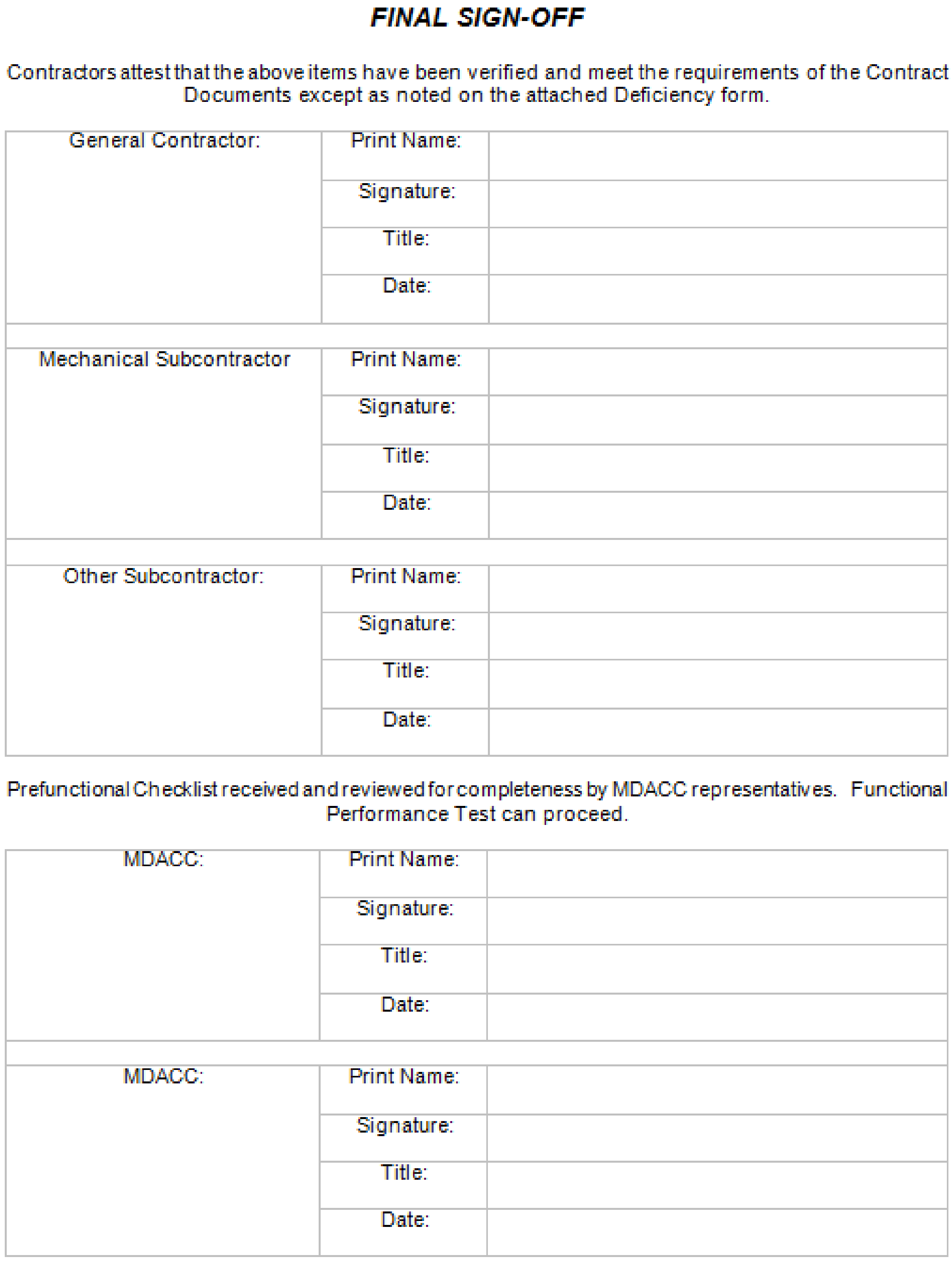


Sensor or Actuator	Correct Location (Y/N) (1)	Thermometer or Gage Value	BAS Value (2)	Instrument Measured Value (3)	Pass (Y/N)
Temperature Sensor					

8. 1. Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.

9. 2. BAS is the Building Automation System. Instrument = testing instrument.

3. All sensors are calibrated within required tolerances ___ YES ___ NO



FINAL SIGN-OFF

Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.

General Contractor:	Print Name:	
	Signature:	
	Title:	
	Date:	
Mechanical Subcontractor	Print Name:	
	Signature:	
	Title:	
	Date:	
Other Subcontractor:	Print Name:	
	Signature:	
	Title:	
	Date:	

Prefunctional Checklist received and reviewed for completeness by MDACC representatives. Functional Performance Test can proceed.

MDACC:	Print Name:	
	Signature:	
	Title:	
	Date:	
MDACC:	Print Name:	
	Signature:	
	Title:	
	Date:	

END OF SECTION 20 08 13 00

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SECTION 20 08 16 00 - HVAC/ PLUMBING/FIRE SUPPRESSION SYSTEMS FUNCTIONAL PERFORMANCE TESTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section expands on and defines responsibilities of the Contractor regarding Functional Performance Tests (FPT's) of the Commissioning process.

B. Contractor shall oversee the Commissioning activities with the Contractor's Subcontractors and the Architect/Engineer (A/E).

C. Prefunctional Checklists, tests and Start-ups are to be completed and documented for the record prior to commencing with FPT's. Refer to Section 20 08 00 and 20 08 13 for additional requirements.

D. Completed FPT Forms for all pieces of equipment and systems shall be submitted to The University prior to Substantial Completion.

E. Refer to Attachments A and B at the end of this Section for example forms that indicate level of documentation required for the Commissioning process.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.04 SUBMITTALS

A. Maintain and use an action item tracking system, "Action Item List," that indicates as a minimum, required information, identified deficiencies, work required, etc.). Each item shall be tracked with the initiator, the parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms. Action Item List shall be distributed and documented using Microsoft Excel or a database format approved by Owner.

B. Disseminate this list as appropriate to keep all parties involved with the FPT informed.

C. Functional Performance Test procedure forms must include the following:

1. System and equipment or component name(s).

2. Equipment location and identification number as identified in the Equipment List/Matrix described in Division 01.

3. Unique test identification number and reference to unique Prefunctional Checklist and Start-up Documentation Identification Numbers for the equipment.

4. Date and time of test.

5. Project name.

6. Participating parties.

7. Specific sequence of operation or other specified parameters, including performance data being verified.

8. Instructions for setting up a Functional Performance Test.

9. Specific script-type, step-by-step procedures to perform a Functional Performance Test, in a clear, sequential and repeatable format that is customized for the system being tested.

10. A Yes/No checkbox (or data entry box as appropriate) for clearly indicating whether proper performance of each part of a Functional Performance Test was achieved with space for actual readings.

11. Section for comments.

12. Signatures and date block for participants and Owner approvals.

D. Refer to Division 01 and 20 08 00 for additional documentation requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 TEST EQUIPMENT

A. Refer to Section 20 08 00 – HVAC/Plumbing/Fire Suppression System Commissioning.

PART 3 - EXECUTION

3.01 PREPARATION

A. The objective of FPT’s is to demonstrate that each system operates according to the Contract Documents through all specified modes of operation.

B. Contractor shall operate each system through all modes of operation (occupied, unoccupied, warm-up, cool-down, etc.) where there is a specified system response. Verification of each sequence in the sequences of operation is required.

C. All equipment, components and devices applicable to the FPT must be started and this Start-up must be documented. This documentation includes completion of the Prefunctional Checklists, pressure testing of equipment, duct, pipe, etc., flushing/cleaning of applicable systems, completed labeling and identification, completed insulation of applicable systems, etc. Refer to Section 20 08 13 for additional Prefunctional Checklist and Start-up requirements.

D. Unless specifically agreed to by the Commissioning Team, all support systems shall be complete prior to FPT.

1. The electrical system serving it is completed and tested.
2. The hydronic systems serving it have been balanced and FPT completed.
3. Balancing has been accomplished on the air and water sides.
4. The building automation system (BAS) has been started and calibrated.

E. Commissioning Team members shall assist in development and review of the optimal sequence of testing.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.03 FUNCTIONAL PERFORMANCE TEST PROCEDURES

A. The purpose of a Functional Performance Test is to verify and document compliance with the stated criteria of acceptance. Contractor shall develop specific script-type test procedures and associated test forms to verify and document proper operation of each piece of equipment and system.

B. Contractor shall operate, or cause to be operated, each system, device, or equipment item, both intermittently and continuously, for a duration period as indicated in the Specification Section(s) for such item and/or in accordance with the manufacturer's written recommendations, the Contract Documents, and the Commissioning Plan.

C. Contractor shall operate each component device and each building system to the full extent of its capability, from minimum to maximum, and under automatic control and manual control.

D. Contractor and manufacturer's representatives shall supervise and coordinate adjustments and balancing of all devices and systems for proper operation prior to requesting the Functional Performance Test(s).

E. Where final balancing of a system is to be performed by Owner or Owner’s consultants, such as final air balancing, Contractor shall provide all services indicated in the applicable Technical Sections and under this Section, including the following prior to Owner’s final balancing:

1. Operational verification of all component devices and the total system, including automatic controls when applicable. Operational verification includes verification that all motors, fans, dampers, and other operable devices are performing in compliance with Specifications throughout their operable range and that all devices are controlled as described in the specified sequence of operation.
2. All tabulated data, motor amperage readings, valve tag verifications, and other data required by Technical Specifications.

F. Where final balancing of a system or components of a system are not specifically indicated to be performed by Owner or Owner's consultants, Contractor shall provide final balancing and adjustments for operation within specified tolerances prior to Functional Performance Test of such system.

G. Sampling: Some types of identical equipment (such as terminal devices) will be tested using a sampling strategy. The sample percentage is indicated below. [Insert equipment list and sampling percentage.]

H. Failure Limit on Sample Tests: With the sampling percentages is listed a failure limit. This limit indicates the maximum percentage of the tested devices that may have any test that fails before an entirely new sample must be tested. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.

1. Where sample tests involve multiple systems (i.e.: Checking strainers on different hydronic systems) the maximum failure limit will apply per system.

I. Deferred Tests: Contractor shall schedule with The University and complete Deferred Tests as part of this Contract during the Warranty Period. Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. Deferred or “Opposite season” tests will be required where scheduling prohibits thorough testing in all modes of operation. Air Handler and central heating system testing for heating related modes of operation and control loops shall be tested during outside air temperatures below 50 degrees F. Air handler and central cooling system testing for cooling related modes of operation and control loops shall be tested during outside air temperatures above 85 degrees F.

J. Provide and deliver the required submitted documentation convenient to testing area. Validate that all required documentation has been submitted to The University and is per the Contract Document requirements.

K. Review the Start-up documentation at the start of FPT’s. Ensure that any items indicated as outstanding in the Prefunctional Checklist is entered as an Action Item and enter one if it is not. The Prefunctional Checklists and Start-up tests/measurements shall be spot checked at the beginning of FPT’s to ensure accuracy. Complete a test that indicates Contractor has reviewed the Prefunctional Checklists and finds the Prefunctional Checklists acceptable and notes any outstanding items.

L. Check for and as applicable direct the Subcontractor to demonstrate that access is sufficient to perform required maintenance.

M. Validate that all prerequisite work is complete and confirm this validation via a test record for documentation.

N. Specifically check labeling and ensure conformance to the Contract Documents.

O. Analyze trends of the system operating parameters to evaluate normal system functionality. The trending requirements are specified in the BAS Commissioning Specification, however all systems must be trended and reviewed prior to and as part of functional performance trending. Subcontractor shall establish these trends, ensure they are being stored properly, and forward the data in electronic format to the Contractor. Analyzed trends shall be organized and/or grouped in a manner that clearly demonstrates the individual components of a piece of equipment is under total control and display this information together. The trend group data shall be labeled with the system name or the purpose of the trend group or data and submitted in a Microsoft Excel spreadsheet.

P. Check proof indication, alarming on failure and restart/acknowledgement as applicable.

Q. Observe operating conditions encountered at the start of the FPT. Contractor shall examine for normal functionality and record parameters as a test.

R. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing. Those on emergency power or uninterruptible power shall be tested on all sources. This test shall generally be coordinated with electrical power systems testing addressed in the Contract Documents.

1. Emergency power tests for mechanical systems will be conducted in concert with the testing of the emergency power systems. Testing Contractor shall be available for the power outage test to test their systems under a power outage. This is in addition to the requirement specified by system.

S. Inspect the installation and compare it to the Contract Documents. Record the inspection as a test.

T. Capacities and adjusted and balanced conditions as applicable will generally be checked.

U. Verify all sequence modes and sequences of operation. Contractor must initiate all modes and may not refer to or rely on a Prefunctional Test done by the building automation system. Some examples of generic modes that apply to most systems include:

1. Off mode.
2. Failed mode: Proof, safeties, power outage etc. See below for crash testing.
3. Start sequence in various modes.
4. Stop sequences in various modes.

V. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation. The Contractor is responsible for placing systems in optimal condition for occupancy and not simply relying on initial design estimated settings.

W. Dynamic Graphics: The graphic for all components, systems, and areas sampled and required to be represented by a graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints are required to be adjustable, verify that they can be adjusted directly from the graphic screen.

X. All interfaces between two systems or equipment of different manufacturers must be checked for accuracy and functionality.

Y. Contractor shall to the extent possible, load the heating and cooling systems during initial FPT’s to check the capacity of the building central systems and initially optimize system settings. This will typically be done using the preheat system to false load the cooling system. This test will incorporate varying the load to check central systems response.

Z. “Crash Testing”: Contractor shall analyze systems to identify possible conditions where functionality may be compromised. Contractor shall design non-destructive tests that will demonstrate either the automated response to the conditions or so that team can identify the best method for responding or fixing the condition. All tests and their findings shall be documented in a Microsoft Excel spreadsheet.

3.04 PARTICIPATION

A. Required participating parties are indicated with the individual tests. Typically, multiple parties are required for any given test, yet participation for any given party is only required for the respective portion of the test for which the party is responsible. In many cases, the maximum required time in hours is indicated in parenthesis for any given test. The time is typically per unit system unless indicated otherwise. If no time is indicated, participation is required throughout the entire test.

B. Frequently, on multiple samples where a given party does not directly conduct the test, the participation of that party will only be required for an initial quantity of systems/equipment. It is required that the parties be available on-site throughout the testing of any given system for which they are required participants. Therefore, time for which they are not directly involved can be spent performing other work (typically addressing identified punch list items or failed test).

C. No party involved with the Project is prohibited from participation in or witnessing of any tests. Any Subcontractor may elect to witness all tests on their systems even if their involvement is not directly required.

D. Coordinate effectively with the individual Subcontractors throughout the development and execution of FPT's and maximize Subcontractors' involvement.

3.05 NON-CONFORMANCE

A. Record results of Functional Performance Tests. Contractor shall report all deficiencies and non-conformance issues to Owner on the Functional Performance Test report form and in a Commissioning deficiency report.

B. At the sole discretion of Owner, Owner may permit the Contractor to make corrections of minor deficiencies observed during a Functional Performance Test. However, the Contractor must document the deficiency and resolution on the appropriate report form.

C. Contractor and Owner will attempt to resolve deficiencies in the following manner:

1. When there is no dispute about a deficiency and Contractor accepts responsibility for correction.

    a. Contractor documents the deficiency and the corrective actions, and then proceeds to another test or sequence. Contractor submits a deficiency report to Owner. Contractor corrects the deficiency, completes the statement of correction form certifying that the equipment or system is ready for retesting, and sends the certification to Owner.

    b. Contractor reschedules test with Owner.

2. When there is a dispute about whether the test indicates a Deficiency, or the Contractor's responsibility for the correction of the apparent Deficiency.

    a. Contractor documents the apparent Deficiency and proceeds to another test or sequence. Contractor submits a Deficiency report to Owner, including the apparent Deficiency.

    b. Contractor facilitates resolution of Deficiency and provides recommendations to The University. Contractor and Owner may bring other parties into the discussions as needed. Final technical interpretive authority is with the Architect/Engineer. Final acceptance authority is with The University.

    c. Contractor documents resolution process.

    d. If Owner agrees with Contractor's interpretation and proposed resolution, Contractor forwards response to Owner. Contractor reschedules test with Owner. Contractor must repeat this process until satisfactory performance and Owner's approval is obtained.

3.06 ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in the Specification Sections applicable to the systems being tested. Unless indicated otherwise, acceptance criteria will be specified with the individual system, equipment, component, or device.

EXAMPLE – FUNCTIONAL PERFORMANCE TEST
HVAC Pumps

Project: ______________________________________ **Project #**:_____________________

Identification of Equipment or System: ____

Location of Equipment or System: ____

Specification Section: ____________________ Detail/Drawing Number: _______________

Manufacturer / Supplier: ____

This Date: __________________ ***Time of Test:*** __________________

FUNCTIONAL PERFORMANCE TEST PROCEDURE NUMBER : ___________________

PREFUNCTIONAL CHECKLIST NUMBER : ___________

Components Included:
___ VFD for pump, ___ Heat Exchanger, ___ Other _________________________________

Other Related Functional Performance Tests: _______________________________________

1. General:

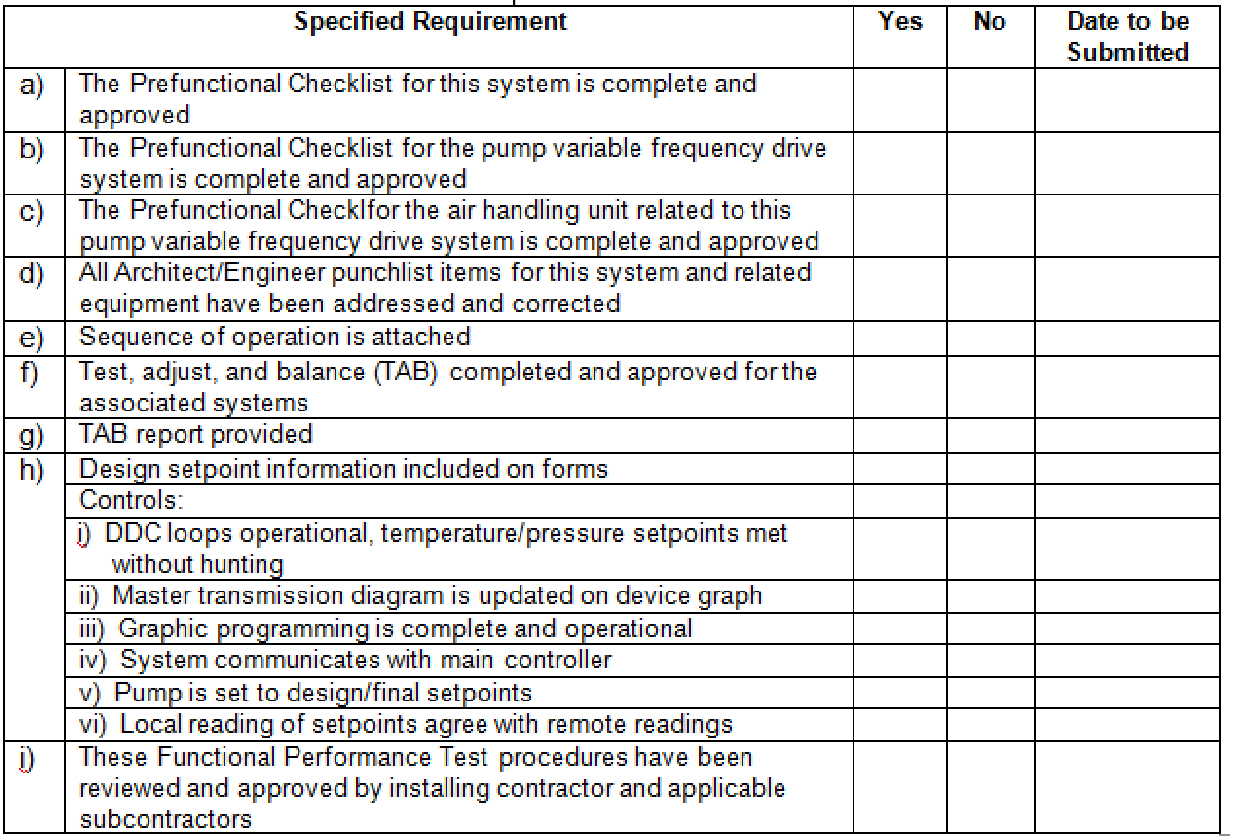
   a. This Functional Performance Test is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Commissioning Deficiency Report upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

   b. ___ Commissioning Deficiency Report attached.

2. Participants:

Name	Company	Role/Participation

3. Functional Performance Test Prerequisites:



Specified Requirement		Yes	No	Date to be Submitted
a)	The Prefunctional Checklist for this system is complete and approved			
b)	The Prefunctional Checklist for the pump variable frequency drive system is complete and approved			
c)	The Prefunctional Checklfor the air handling unit related to this pump variable frequency drive system is complete and approved			
d)	All Architect/Engineer punchlist items for this system and related equipment have been addressed and corrected			
e)	Sequence of operation is attached			
f)	Test, adjust, and balance (TAB) completed and approved for the associated systems			
g)	TAB report provided			
h)	Design setpoint information included on forms			
	Controls:			
	i) DDC loops operational, temperature/pressure setpoints met without hunting			
	ii) Master transmission diagram is updated on device graph			
	iii) Graphic programming is complete and operational			
	iv) System communicates with main controller			
	v) Pump is set to design/final setpoints			
	vi) Local reading of setpoints agree with remote readings			
i)	These Functional Performance Test procedures have been reviewed and approved by installing contractor and applicable subcontractors			

4. Functional Performance Test Procedure:

Step	Mode	Test Procedure	Expected Response	Pass	
				Yes	No
1	Pump Off	Standby check. HOA in Auto position. Unit commanded Off by BAS.	Verify by visual inspection that: a) Discharge gauge pressure equals suction gauge pressure. b) No rotation of pump shaft. c) Pump light indication shows pump is off. Pump indication shows pump as being Off at the BAS.		
2	Pump Start-up	HOA in Auto position. Unit commanded On by BAS.	Verify by visual inspection that: a) Discharge gauge pressure greater than suction gauge pressure. b) Rotation of pump shaft. c) Pump light indication shows pump is on. Pump indication shows pump as being On at the BAS.		
3	Pump Operation	HOA in Auto position. Test results are recorded in table.	Verify by local and remote reading that test results correspond with TAB report and sequence of operation as described in the Contract Documents.		
4	Simulate Pump Overload Trip	HOA in Auto position. Test results are recorded in table.	BAS indicates an alarm for Pump Trip condition.		
5	Simulate Loss of Pump Flow	HOA in Auto position. Test results are recorded in table. Isolate DP switch across suction and discharge of pump and open sensing line vent valves to relieve pressure across DP switch.	BAS indicates an alarm condition for Loss of Pump condition.		

5. Comments:

FINAL SIGN-OFF

Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Commissioning Deficiency Report.

General Contractor:	Print Name:
	Signature:
	Title:
	Date:
Mechanical Subcontractor	Print Name:
	Signature:
	Title:
	Date:
Other Subcontractor:	Print Name:
	Signature:
	Title:
	Date:

Functional Performance Test procedure received and reviewed for completeness by MDACC representatives. Integrated System Test can proceed.

MDACC:	Print Name:
	Signature:
	Title:
	Date:
MDACC:	Print Name:
	Signature:
	Title:
	Date:

EXAMPLE – FUNCTIONAL PERFORMANCE TEST
Air Handling Units - Modular

Project: ______________________________________ **Project** #:_____________________

Identification of Equipment or System: ____

Location of Equipment or System: ____

Specification Section: ____________________ Detail/Drawing Number: _______________

Manufacturer / Supplier: ____

This Date: __________________ ***Time of Test:*** __________________

FUNCTIONAL PERFORMANCE TEST PROCEDURE NUMBER : ___________________

PREFUNCTIONAL CHECKLIST NUMBER : ___________

Components Included:
___ VFD for AHU, ___ Return Fans (RF), ___ Outside Air Handling Unit, AHU _______,
Other __________________________________

Other Related Functional Performance Tests: _______________________________________

1. General:

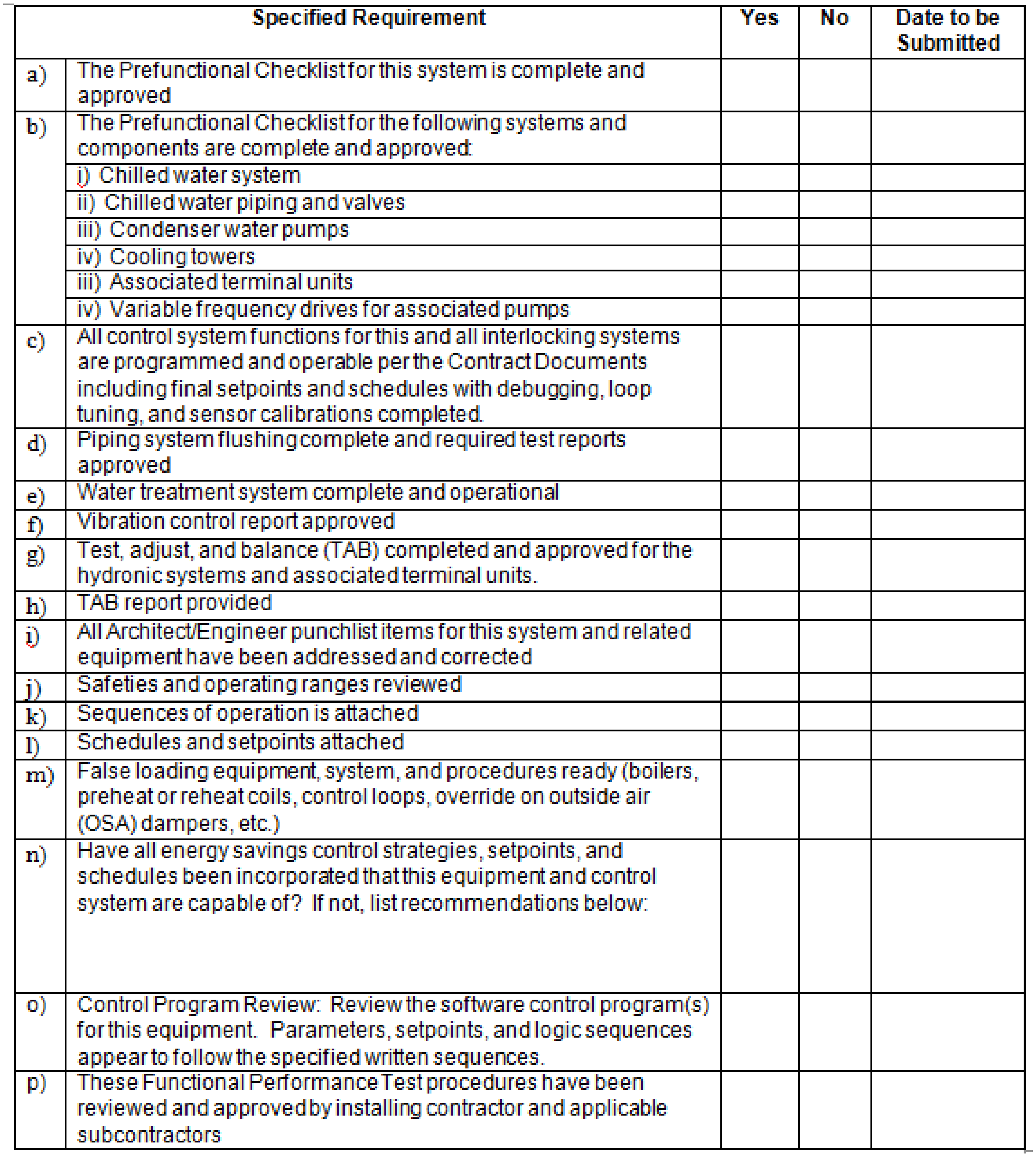
   a. This Functional Performance Test is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Commissioning Deficiency Report upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

   b. ___ Commissioning Deficiency Report attached.

2. Participants:

Name	Company	Role/Participation

3. Functional Performance Test Prerequisites:



Specified Requirement		Yes	No	Date to be Submitted
a)	The Prefunctional Checklist for this system is complete and approved			
b)	The Prefunctional Checklist for the following systems and components are complete and approved:			
	i) Chilled water system			
	ii) Chilled water piping and valves			
	iii) Condenser water pumps			
	iv) Cooling towers			
	iii) Associated terminal units			
	iv) Variable frequency drives for associated pumps			
c)	All control system functions for this and all interlocking systems are programmed and operable per the Contract Documents including final setpoints and schedules with debugging, loop tuning, and sensor calibrations completed.			
d)	Piping system flushing complete and required test reports approved			
e)	Water treatment system complete and operational			
f)	Vibration control report approved			
g)	Test, adjust, and balance (TAB) completed and approved for the hydronic systems and associated terminal units.			
h)	TAB report provided			
i)	All Architect/Engineer punchlist items for this system and related equipment have been addressed and corrected			
j)	Safeties and operating ranges reviewed			
k)	Sequences of operation is attached			
l)	Schedules and setpoints attached			
m)	False loading equipment, system, and procedures ready (boilers, preheat or reheat coils, control loops, override on outside air (OSA) dampers, etc.)			
n)	Have all energy savings control strategies, setpoints, and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below:			
o)	Control Program Review: Review the software control program(s) for this equipment. Parameters, setpoints, and logic sequences appear to follow the specified written sequences.			
p)	These Functional Performance Test procedures have been reviewed and approved by installing contractor and applicable subcontractors			

4.

5. Current Setpoints for Functional Performance Test Procedure:

c. Record all values for current setpoints (SP), control parameters, limits, delays, lockouts, schedules, etc., changed to accommodate testing.

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Discharge air static pressure (SP)		
Discharge air temp.		
Static P. reset schedule		
Discharge air reset schedule		

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Building static pressure		
Dirty filter D.P.		
OSA CFM		

6. Sensor Calibration Checks:

d. Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during Prefunctional Checklist.

e. "In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage, or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the Prefunctional Checklist requirements (___________________________). If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Sensor & Location	Loc-ation OK[1]	1st Gage or BAS Value	Instr. Meas'd Value	Final Gage or BAS Value	Pass Y/N?
DAT					
RAT					
OSAT					

Sensor & Location	Loc-ation OK[1]	1st Gage or BAS Value	Instr. Meas'd Value	Final Gage or BAS Value	Pass Y/N?
Dis-charge SP					

[1] Sensor location is appropriate and away from causes of erratic operation.

7. Device Calibration Checks:

f. The actuators or devices listed below checked for calibration. This is a spot check on a sample of calibrations done during Prefunctional Checklist and start-up.

g. "In calibration" means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. Fix items out of calibration or adjustment, via an offset in the BAS, or a mechanical fix.

Device or Actuator & Location	Procedure / State	1st BAS Value	Site Observation	Final BAS Reading	Pass Y/N
Cooling coil valve (CCV) position or command and stroke*	1. Intermediate positions				
	2. Full open				
	3. Increase pressure (open)				
	4. Closed				
	5. Remove power or air (closed)				
Relief damper position **	1. Closed				
	2. Full open				
Mixed air damper position **	1. Closed				
	2. Full open				
Main OSA damper position**	1. Closed				
	2. Full open				
Min. OSA damper position**	1. Closed				
	2. Full open				
Variable frequency drive speed (VFD)***	1. Min.: ___________%				
	2. Max.: ___________%				

* Set pumps to normal mode. Procedure 1. Command valve to a few intermediate positions. Verify that readings in BAS reasonably correspond to the actual positions. For cooling coil valves (NO): Procedure 2. Lower space setpoint to 20 deg. F. below space temperature. Verify BAS reading says CCV is 100% open. Visually verify valve is 100% open. Procedure 3. For pneumatic actuators, by override in the BAS, increase pressure to valve by ____ psi (do not exceed actuator rating). Verify valve stem and actuator position does not change. Restore to normal. Procedure 4. Set space setpoint to 20F above space temperature. Verify BAS reading says CCV is closed. Visually verify valve is closed. Procedure 5. Remove control air or electricity from the valve and verify that the valve stem and actuator position do not change.

** 1. Command damper closed and verify that damper is shut and BAS reads shut.
2. Do the same, commanding damper fully open.

*** VFD: Procedure 1. Lower the controlling static pressure setpoint (duct or discharge) to be 1/4 of its current value. Verify that the vanes are shut, or fan speed is at minimum for VFD and packaged controller reads the same. Return the static pressure setpoint to normal. Procedure 2. Lower the space temperature setpoint to be 20F below space temperature and cause TU dampers to go to full cooling. Raise the static pressure setpoint as necessary to cause the setpoint to not be met. Verify that the inlet vanes are fully open or the fan speed is at its maximum and verify that the packaged controller reads the same. Return all to normal.

NOTES:

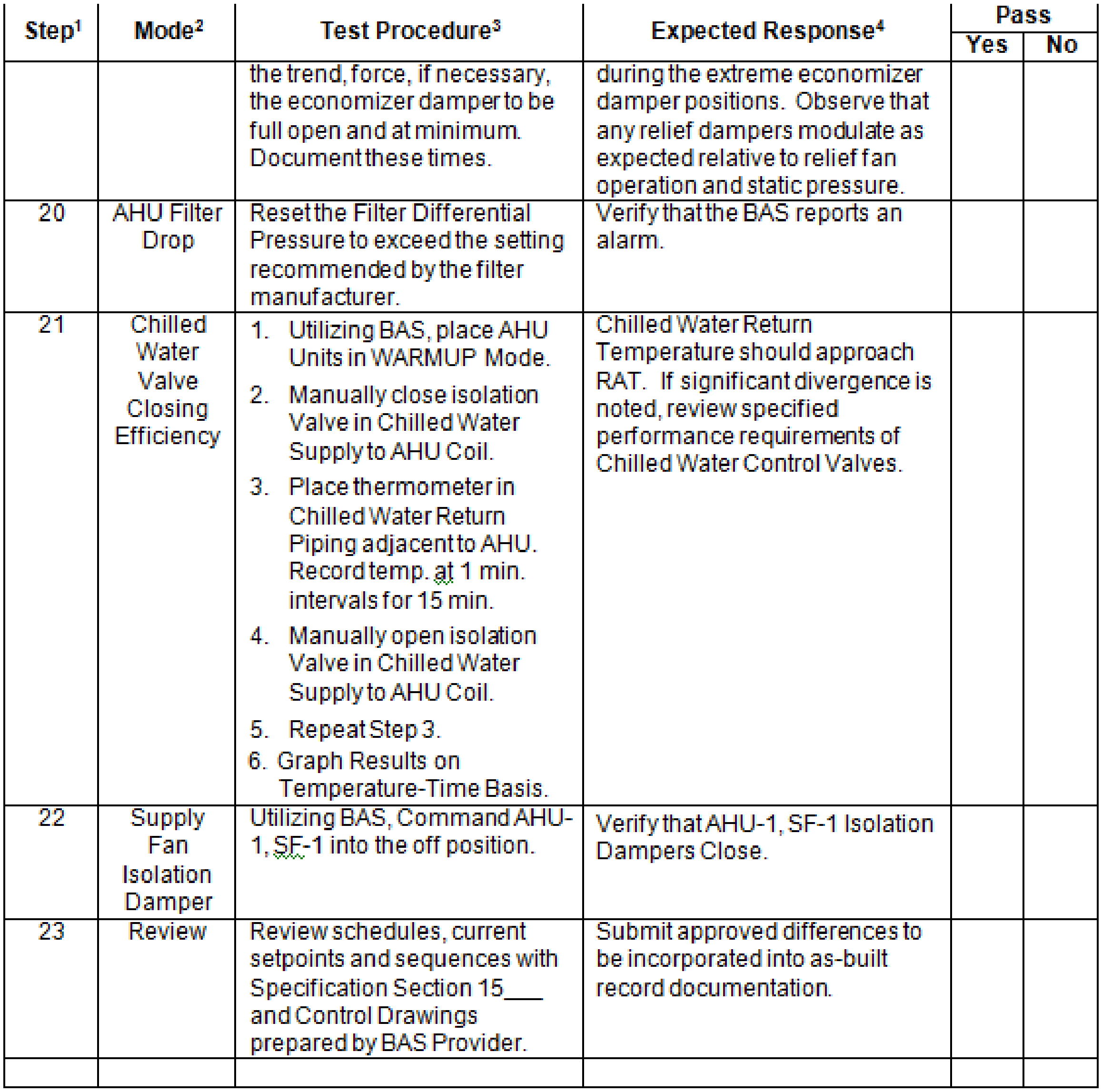
8. Functional Performance Test Procedure:

Step[1]	Mode[2]	Test Procedure[3]	Expected Response[4]	Pass	
				Yes	No
1	Fan Off	Standby check with units commanded Off by BAS.	Verify by visual inspection that: 1. Return Air Dampers to AHU- are Open. 2. Outside Air Dampers in AHU- are Closed. 3. Isolation Dampers on AHU- are Closed. 4. Relief Dampers in RF- are Closed. 5. Cooling Coil Valve on Cooling Coil of AHU- is Closed.		
2	Unit Start-up	With units commanded on by BAS.	1. Supply Fan Isolation Dampers Open in AHU- 2. Supply Fan start through VFDs 3. Supply Fan Isolation Dampers in AHU- Open 4. AHU- Fans Start 5. RF- Isolation Dampers Open 6. RF- Fans start through VFDs 7. Exhaust Fans EF- start.		
3	RF Volume Control	1. Verify RF Volume, utilizing airflow meters in Return Fans RF____, Supply Fans in AHU-____ and Garage Exhaust Fan EF-1, and TAB established CFMs for Exhaust Fans EF-__, and ___, TAB established Fixed Differential, make the following calculation: (Return Air Flow=Supply Air Flow, - EF-1and2 Flow, -SF1 Flow-Fixed Differential} 2. Trend Log RF____, AHU ____, and SF-1 airflow rates at 5 min. intervals. Command off EF-1 and 2 sequentially at 5 min. Intervals.	Verify that RF airflow meter readings correspond to calculation. Verify that RF airflow meter readings continue to correspond to calculation		
4	Duct	Disable Duct Static Pressure	Verify that VFD's modulate as		

Step[1]	Mode[2]	Test Procedure[3]	Expected Response[4]	Pass	
				Yes	No
	Static Pressure Control	Reset utilizing BAS Software. Adjust space temperature setpoint on significant quantity of zones to be well below observed reading.	required to maintain SP setpoint without hunting or overshooting setpoint.		
5	High Static Pressure Alarm and Shutdown	With units running at low flow condition, utilizing a squeeze bulb, simulate an increase in discharge air static pressure.	Verify that BAS indicates an alarm condition at ___" WG and shuts fans down at ___"WG		
6	Static Pressure Reset	1. For Perimeter Terminal Units on floors 9-16, Reset space temperature setpoints to be below space temperatures. Utilizing BAS trend logging capabilities, Record at 5 min. intervals, Discharge Air SP Spt, Perimeter TU Units in saturation. 2. Reset space temperature setpoints to be above space temperatures. Utilizing the same Trending as above, Record the same data points.	Verify that DA SP Spts increase by ___" WG at __ min intervals until only one Perimeter TU remains in saturation. Verify that setpoints are met and maintained without excessive hunting. Verify that DA SP Spt decreases by ___"WG at __ min intervals until one Perimeter TU reaches saturation.		
7	Discharge Temp. Reset	1. For Perimeter Terminal Units Floors 1-2, Reset space sensor setpoints to be above space temperatures. Utilizing BAS Trend Logging, at 6 min intervals, record DAT setpoint, DAT, and perimeter TU cooling Flow rates. 2. For Perimeter Terminal Units Floors 1-2, Reset space sensor setpoints to be below space temperatures. Utilizing BAS Trend Logging, at 6 min intervals, record DAT setpoint, DAT, and perimeter TU cooling Flow rates.	Verify that Discharge Air Temperature Setpoint is reset upwards at 2 deg increments every 6 min to maintain design cooling CFM at 5 perimeter TU's to maintain design cooling CFM Verify that Discharge Air Temperature Setpoint is reset downwards at 2 deg increments every 6 min to reach design cooling CFM at only 5 perimeter TU's. Both should happen without excessive hunting.		
8	Smoke Conditions	Interfacing with EC, simulate a fire mode with the Fire Alarm System.	Verify that AHU System returns to FAN OFF Status, with OSA and Relief Dampers in a Closed Position.		
9	Warm-up Control	Place Unit's BAS Control Mode into Warmup. Overwrite RAT Sensor Reading to be 65 Deg.	Verify that dampers assume a 100% Return Air Mode.		

9.

Step[1]	Mode[2]	Test Procedure[3]	Expected Response[4]	Pass	
				Yes	No
		F.			
10	Warm-up Control	Place Unit's BAS Control Mode in Warmup. Overwrite RAT Sensor Reading to be ___ Deg. F.	Verify that unit returns to Normal Operation Mode.		
11	Freeze Condition	Overwrite Low Limit Detection Thermostat reading to be __ Deg. F.	Verify that system alarms, fans stop, OSA Dampers close, Relief Dampers Close, and RA dampers open.		
12	Return Fan Static Pressure	With AHU Unit __ running at low air flow condition, Overwrite RF __ return air fan inlet SP to a reading below -___" W.G.	Verify that system alarms and that all Fans are shut down.		
13	Manual Smoke Pressuriz. System	With Fire Alarm System in alarm, utilizing control panel in Fireman Control Center, select a floor and place floor into purge mode.	Verify that Single Fan operates, Isolation dampers open only on selected Fans, Return Fans are off, Outside Air Handling Units are off, OSA dampers open, and return air dampers close.		
14	Minimum OSA Unit Fan Off	Command AHU-1&2 System off.	Verify that AHU ___ isolation dampers are closed, and if OSA temperature is above __ Deg. F, heating coil control valve is closed.		
15	Minimum OSA Unit Fan Off	Simulate a OSA temperature below 35 Deg. F.	Verify that heating coil control valve opens.		
16	Minimum OSA Unit Temp. Control	Utilizing BAS software, reset discharge air setpoint to 80 Deg. F.	Verify that Face and Bypass Dampers and Heating Coil Control Valves modulate in sequence to maintain __ Deg. F. Setpoint.		
17	Minimum OSA Unit Freeze Condition	Simulate a condition at low limit detection thermostat of below 40 Deg. F.	Verify that BAS system goes into alarm, AHU-__ Fans Shut Down, AHU-___ Isolation Dampers Close, and Heating Valve Opens.		
18	On-Floor Return Fan Operation	Place AHU-____ in normal operating mode.	Verify that RAF __-__ Start and Run.		
19	Building Static Pressure	Trend log the supply fan speed, the relief fan speed, relief damper position and the building static pressure for 12 hrs at 20 min. intervals. During	Observe in the trends that the building static pressure is maintained within +/- 0.05" of setpoint without excessive hunting. Carefully examine		



Step[1]	Mode[2]	Test Procedure[3]	Expected Response[4]	Pass	
				Yes	No
		the trend, force, if necessary, the economizer damper to be full open and at minimum. Document these times.	during the extreme economizer damper positions. Observe that any relief dampers modulate as expected relative to relief fan operation and static pressure.		
20	AHU Filter Drop	Reset the Filter Differential Pressure to exceed the setting recommended by the filter manufacturer.	Verify that the BAS reports an alarm.		
21	Chilled Water Valve Closing Efficiency	1. Utilizing BAS, place AHU Units in WARMUP Mode. 2. Manually close isolation Valve in Chilled Water Supply to AHU Coil. 3. Place thermometer in Chilled Water Return Piping adjacent to AHU. Record temp. at 1 min. intervals for 15 min. 4. Manually open isolation Valve in Chilled Water Supply to AHU Coil. 5. Repeat Step 3. 6. Graph Results on Temperature-Time Basis.	Chilled Water Return Temperature should approach RAT. If significant divergence is noted, review specified performance requirements of Chilled Water Control Valves.		
22	Supply Fan Isolation Damper	Utilizing BAS, Command AHU-1, SF-1 into the off position.	Verify that AHU-1, SF-1 Isolation Dampers Close.		
23	Review	Review schedules, current setpoints and sequences with Specification Section 15___ and Control Drawings prepared by BAS Provider.	Submit approved differences to be incorporated into as-built record documentation.		

Record Footnotes:
[1]Sequences of operation specified in Contract Documents (attached).
[2]Mode or function ID being tested from testing requirements of the Contract Documents.
[3]Step-by-step procedures for manual testing, trend logging, or data-logger monitoring.
[4]Include tolerances for a passing condition.
[5]Record any permanently changed parameter values and submit to Owner.

10. Comments:

FINAL SIGN-OFF

Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Commissioning Deficiency Report.

General Contractor:	Print Name:	
	Signature:	
	Title:	
	Date:	
Mechanical Subcontractor	Print Name:	
	Signature:	
	Title:	
	Date:	
Other Subcontractor:	Print Name:	
	Signature:	
	Title:	
	Date:	

Functional Performance Test procedure received and reviewed for completeness by MDACC representatives. Integrated System Test can proceed.

MDACC:	Print Name:	
	Signature:	
	Title:	
	Date:	
MDACC:	Print Name:	
	Signature:	
	Title:	
	Date:	

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Specification	Specification Description
22 00 00 00	Plumbing specialties
22 01 40 00	Plumbing fixtures
22 05 13 00	Common motor requirements for plumbing equipment
22 05 23 00	General valves for plumbing piping
22 05 76 00	Sanitary Sewage
22 10 23 00	Plumbing pumps
22 11 16 00	Plumbing Piping
22 11 16 00a	Sanitary Waste and Vent Piping
22 11 16 00b	Steam and Condensate piping
22 11 16 00c	General Service and Compresses Air Piping
22 11 16 00d	Medical Vacuum and Gas Piping
22 11 19 00	Lab Vacuum and Gas pipingPerformance Tests
22 11 19 00a	Lab Waste and Vent pipng
22 43 39 00	Medical Plumbing Fixtures
22 60 00 00	Emergency Shower and Eye Wash equipment
22 60 00 00a	High Purity Water Systesm (RO)

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SECTION 22 01 00 00 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Provide all materials and installation for plumbing specialties within building domestic water, sanitary waste and storm drainage systems; floor drains, floor sinks, hub drains, roof drains, cleanouts, backflow preventers, vacuum breakers, pressure regulating valves, water hammer arrestors, wall hydrants, hose bibs, trap primer units, strainers, temperature gauges, pressure gauges and other normal parts that make the systems complete, operable, code compliant and acceptable to the authorities having jurisdiction.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. 2015 Edition of the International Plumbing Code.
2. ANSI/NSF Standard 61 - Drinking Water System Components - Health Effects.
3. Americans with Disabilities Act (ADA).
4. ASHRAE/IESNA 90.1.
5. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
6. ASTM A312/A312M – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
7. ASTM A999 – Standard Specification for General Requirements for Alloy and Stainless Steel Pipe.
8. ASTM D1784 - Standard Specification for Rigid Poly Vinyl Chloride) (PVC) compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
9. ASTM D1785 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
10. ASTM D2467 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.

11. ASTM D2564 – Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping.

12. ASME B36.10M – Standard for welded and seamless steel pipe Systems.

13. ASME B1.20.1 – Pipe Threads, General Purpose, Inch.

14. ANSI/AWWA C-606 – Standard for grooved and shouldered joints.

15. ANSI/MSS-SP-114 – Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000.

16. ASSE 1079 – Performance requirements for Dielectric Pipe Unions.

17. Energy Conservation Design Standard for New State Buildings.

18. Factory Mutual Approvals Division (FM).

19. International Energy Conservation Code (IECC).

20. International Building Code.

21. International Fuel Gas Code.

22. MSS SP 25 – Standard Marking System for Valves, Fittings, Flanges, and Unions.

23. MSS SP 67 – Standard Practice covering dimensions, design, testing, and marking requirements for butterfly valves.

24. MSS SP 110 – Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

25. MSS SP 139 – Copper Alloy Gate, Globe, Angle, and check Valves for Low Pressure/Low Temperature Plumbing Specifications.

26. NEMA – ANSI: National Electrical Manufacturers Association – for plumbing systems requiring electrical equipment.

27. NFPA 1 – Fire Code.

28. NFPA 51 – Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes.

29. NFPA 54 – National Fuel Gas Code.

30. NFPA 70 – National Electrical Code.

31. NFPA 99 – Health Care Facilities Code.

32. NFPA 101 – Life Safety Code.

33. NFPA 211 – Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.

34. NFPA 241 – Construction, Alteration and Demolition Operations.

35. Occupational Safety and Health Act (OSHA).

36. Texas Accessibility Standards (TAS).

37. Uniform Plumbing Code (UPC).

D. While a number of applicable sections of the aforementioned codes and standards have been identified in portions of this Specification, the Vendor has the ultimate responsibility for the complete identification and execution of all applicable sections of the aforementioned codes and standards.

E. Unless otherwise stated, these codes, standards or material specifications shall be the latest revisions, including all effective publications, supplements, addenda and editions in effect at the issuance date of this document.

F. These codes and standards set forth the minimum requirements. These may be exceeded by the Vendor if, in its judgment and with Owner's acceptance, superior or more economical designs or materials are available.

G. The most severe requirements shall prevail in the event of conflict between requirements, specifications and applicable and governing codes. All conflicts among the Codes, specifications and/or purchase order shall be brought to the Owner's attention for written resolution prior to release for fabrication.

H. It is the vendor's responsibility that all equipment and materials furnished and installed be in strict conformity with all current, applicable codes and regulations of the state of Texas. Violations resulting from stipulations in the existing codes shall be corrected by the vendor at its own expense.

I. The Vendor shall be responsible for obtaining copies and paying all costs of all applicable codes and regulations.

J. The Vendor shall be responsible for paying all costs associated with compliance with all applicable codes and regulations.

1.04 DEFINITIONS

A. These definitions are included to clarify the direction and intention of these specifications. For further clarification, contact the Architect/Engineer.

1. Concealed / Exposed: "Concealed" areas are those areas that cannot be seen by the building occupants. "Exposed" areas are all areas, which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms. "Exterior" areas are those that are outside the building exterior envelope and exposed to the outdoors.

2. Furnish: The term "furnish" means to supply and deliver to the project site, and ready for unloading, unpacking, assembly, installation, and similar operations.

3. Install: The term "install" means operations at Project Site including unloading, unpacking, storing, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

4. Provide: The term "provide" means to furnish and install, complete and make ready for the intended use.

1.05 QUALITY ASSURANCE

A. Manufacturer's name and pressure rating shall be permanently marked on valve body.

B. All materials shall be new, undamaged, and free of rust. Protect installed products and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc. Remove dirt and debris as work progresses.

C. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section.

D. Installer Qualifications: Company shall have minimum three years documented experience specializing in performing the work of this section. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

E. Plumbing systems shall be coordinated with (and as required by documents to provide services to) other systems and trades to include but not be limited to mechanical systems, electrical systems, fire suppression systems, fire alarm systems, security systems, transport systems, telephone systems, data systems and site work. All water pipes shall be routed around telecom rooms.

F. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of Contractor's work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions and dimensions in the field, and advise the Architect/Engineer of any discrepancy before performing any work. Incidental adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

G. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the Site.

H. The drawings are subject to the requirements of Reference Standards, structural, and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

I. When the Drawings do not give exact details as to the elevation of pipe, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas. In building occupied areas where pipe elevations are not provided, the Contractor shall coordinate with Building Owner prior to pipe installation to identify any specific clearance restrictions and requirements.

J. Before starting work, the Contractor shall verify all associated existing systems, pipe sizes, locations, and dimensions so that the new systems can be properly connected as indicated on the documents.

1.06 SUBMITTALS

A. Product Data:

1. Provide Code and Standards compliance, component dimensions, service sizes and finishes.

B. Record Documents:

1. Manufacturer's certification documentation for backflow preventers.
2. Submit proposed location of access panels which vary from quantities or locations indicated on Contract Drawings.
3. Provide full written description of manufacturer's warranty.
4. Record actual locations of plumbing specialties installed.

C. Operation and Maintenance Data:

1. Include testing procedures for backflow preventers, adjustment procedures for water pressure regulating valves.

2. Include installation instructions, exploded assembly views. servicing requirements, inspection data, installation instructions, spare parts lists, replacement part numbers and availability, location and contact numbers of service depot, for all plumbing specialties installed.

1.07 DELIVERY, STORAGE AND HANDLING

A. Accept specialties on site in shipping containers and maintain in place until installation.

B. Provide temporary protective coating and end plugs on valves not packaged within containers. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work and isolating parts of completed system.

D. Protect all materials before and after installation from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for installation within exterior environments.

1.08 EXTRA MATERIALS

A. Provide two loose keys for each type of wall hydrant box.

B. Provide manufacturer’s standard test kit for each type of backflow preventer installed.

1.09 WARRANTY

A. All plumbing systems, components and controls shall be provided with a minimum 1-year warranty that shall start upon Substantial Completion of the project.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide plumbing specialties as indicated and scheduled on the Contract Drawings and as specified herein. All materials and work shall meet or exceed all applicable Federal and State requirements and conform to adopted codes and ordinances of authorities having jurisdiction.

C. Pressure ratings of plumbing specialties shall be suitable for the anticipated system pressures in which they are installed.

D. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61.

E. All brass and bronze plumbing specialties within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content.

F. Specialties of same type shall be product of one manufacturer.

2.02 ACCEPTABLE MANUFACTURERS

A. Floor Drains: Josam or approved equal.

B. Floor Sinks: Josam. or approved equal

C.	Roof Drains:	Josam or approved equal.
D.	Wall/Floor Cleanouts:	Josam or approved equal.
E.	Backflow Preventers:	Conbraco or approved equal.
F.	Water Pressure Regulating Valves:	Watts Regulator or approved equal
G.	Water Hammer Arrestors:	Josam or approved equal.
H.	Wall Hydrants:	Josam or approved equal.
I.	Hose Bibbs:	Chicago or approved equal
J.	Trap Primer Units:	As Specified Herein or approved equal
K.	Strainers:	Conbraco, Wilkins, Watts
L.	Temperature Gauges:	Ashcroft, Trerice, Weksler
M.	Pressure Gauges:	Ashcroft, Trerice, Weksler

2.03 FLOOR DRAINS (FD)

A. All floor drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.

B. Each floor drain shall be provided with a deep-seal p-trap unless noted otherwise.

C. Floor drains installed for general floor area drainage within toilet rooms and other finished spaces shall have cast iron body with flange, adjustable top and sediment bucket, integral reversible clamping collar, seepage openings, 1/2" plugged primer tap, and 6” diameter nickel bronze or stainless steel strainer with vandal proof screws.

D. Floor drains installed for general floor area drainage and light to medium flow indirect equipment discharge within mechanical rooms shall have cast iron body with plugged 1/2" primer tap, integral clamping collar, seepage openings, adjustable top and 11-1/2” diameter ductile iron loose set tractor grate.

E. Floor drains installed for non-monolithic shower stall floors shall have cast iron body with flange, adjustable top and sediment bucket, integral reversible clamping collar, seepage openings and 5” diameter nickel bronze or stainless steel strainer with vandal proof screws.

F. All floor drains shall be as sized and scheduled on Contract Drawings.

2.04 FLOOR SINKS (FS)

A. All floor sinks shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.

B. Each floor sink shall be provided with a deep-seal p-trap unless noted otherwise.

C. Floor sinks installed for general floor area drainage shall have 8” round cast iron body with 3" sump, acid resistant enamel interior, aluminum dome strainer, seepage flange, membrane clamping device and 7-3/8” diameter stainless steel or nickel bronze top.

D. Floor sinks installed to receive indirect equipment discharge shall have cast iron 12" square body with 8" sump, acid resistant enamel interior, aluminum dome strainer, seepage flange, membrane clamping device and stainless steel top. Top shall be ½ or ¾ grate as scheduled on Drawings.

E. All floor sinks shall be as sized and scheduled on Contract Drawings.

2.05 HUB DRAINS (HD)

A. Hub drains shall be cast iron soil pipe hubs or hub adapters set with top of hub one-half inch (1/2”) above finished floor. Each hub drain shall be provided with a deep-seal P-trap.

2.06 ROOF DRAINS (RD)

A. Primary roof drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted and have lacquered cast iron body with sump, removable cast iron or bronze dome strainer, flashing flange and clamp, gravel stop, deck clamp and drain receiver. Provide extension where required.

B. Roof drains shall be sized as indicated on Contract Drawings.

2.07 CLEANOUTS:

A. Cleanouts shall be the same nominal size as the pipe they serve up to four inches. For pipes larger than four inches nominal size, the size of cleanouts shall be six inches.

B. Cleanouts shall have cast iron body with tapered cast brass or bronze plug providing gas and watertight seal.

C. Interior floor cleanouts shall have stainless steel or nickel bronze scoriated top. Provide carpet marker when installed in areas to be covered by carpet.

D. Exterior cleanouts at grade shall have scoriated cast iron top.

E. Wall cleanouts shall be provided with stainless steel access covers of adequate size to allow rodding of drainage system. Wall cleanouts incorporating cover screws that extend completely through the access plug are not acceptable.

2.08 BACKFLOW PREVENTERS

A. Reduced Pressure Zone Type (Not for Use in Fire Protection Water Supply):

1. The assembly shall meet the requirements of ASSE 1013, AWWA C511.
2. The assembly shall consist of a pressure differential relief valve located in a zone between two positive seating check valves and captured springs. Backsiphonage protection shall include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel. The assembly shall include two tightly closing shutoff valves before and after the valve and test cocks.
3. Test cocks
4. Seats: Bronze, removable and replaceable without removing valve from the line.
5. Checks: Independently operating.
6. Relief Valve: Independently operating, located between the two check valves.
7. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 110°F.
8. Unit to be complete with vent-port funnel to maintain the air gap and to provide a drain connection point.
9. Sizes 1/4" and 1/2" - Bronze body, bronze strainer, upstream and downstream quarter-turn ball valves, union connections: Watts Regulator Company Series 009.

10. Sizes 1/2" through 2" - Bronze body, bronze strainer, upstream and downstream quarter-turn ball valves, union connections: Watts Regulator Company Series 919.
11. Sizes 2-1/2" through 10" - FDA epoxy coated cast iron body, FDA epoxy coated strainer, upstream and downstream OSY – UL/FM outside stem and yoke resilient seated gate valves, flange connections: Watts Regulator Company Series 909.

B. Reduced Pressure Zone Type (For Use in Fire Protection Water Supply):

1. The assembly shall meet the requirements of ASSE 1013, be U.L. classified and FM Approved.
2. The assembly shall consist of a pressure differential relief valve located in a zone between two positive seating check valves and captured springs. Backsiphonage protection shall include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel. The assembly shall include two tightly closing shutoff valves before and after the valve and test cocks.
3. Test cocks
4. Replaceable seats
5. Checks: Independently operating.
6. Relief Valve: Independently operating, located between the two check valves.
7. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 110°F.
8. Unit to be complete with vent-port funnel to maintain the air gap and to provide a drain connection point.
9. Sizes 2-1/2" through 10" - Schedule 40 stainless steel body, upstream and downstream UL/FM outside stem and yoke resilient seated gate valves or UL/FM grooved gear operated butterfly valves with tamper switches: Watts Regulator Company Series 957.

C. Double Check Valve Assembly (Not for Fire Protection Water Supply):

1. The assembly shall meet the requirements of ASSE 1015, AWWA C510
2. Top entry access points for each check assembly
3. Replaceable seats
4. Test cocks
5. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 110°F.
6. Sizes 1/2" through 2" - Bronze alloy body, bronze strainer, upstream and downstream quarter-turn ball valves, union connections: Watts Regulator Company Series 719.
7. Sizes 2-1/2" through 10" - FDA epoxy coated cast iron body, FDA epoxy coated strainer, upstream and downstream OSY – UL/FM outside stem and yoke resilient seated gate valves, flange connections: Watts Regulator Company Series 709.

D. Double Check Valve Assembly (For Use in Fire Protection Water Supply):

1. The assembly shall meet the requirements of ASSE 1015, be U.L. classified and FM Approved.
2. Two independent tri-link check modules within a single housing

3. Sleeve access port

4. Four test cocks

5. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 110°F.

6. Sizes 2-1/2" through 10" - Schedule 40 stainless steel body, upstream and downstream UL/FM outside stem and yoke resilient seated gate valves or UL/FM grooved gear operated butterfly valves with tamper switches: Watts Regulator Company Series 757.

E. Continuous Pressure Vacuum Breaker (Not for Use in Fire Protection Water Supply):

1. Tested and certified under ASSE Standard 1020 and CSA Standard B64.1.2.

2. Suitable for continuous pressure hot and cold water.

3. Brass body and seat with silicone rubber discs.

4. Rated maximum pressure 150 psi and working temperature 33 to 140 degrees F.

5. Complete with quarter turn ball valves and test cocks.

6. Sizes 3/8” through 1” - Spill-resistant, Watts Regulator Company Series 008PCQT.

7. Sizes 1-1/4” through 2” - Watts Regulator Company Series 800M4QT.

2.09 WATER PRESSURE REGULATING VALVES

A. All bronze body, integral Monel strainer screen, built-in bypass, nylon reinforced Neoprene diaphragm, renewable seat and union end connection, rated for water temperature up to 180°F and 300 psi inlet pressure, manufactured by Wilkins Series 600 or approved equal by Watts.

2.10 WATER HAMMER ARRESTORS (SHOCK ABSORBERS):

A. Nesting type bellows operated water hammer arrestor with male N.P.T. connection. Bellows and body casing made of Type 304 stainless steel. Water hammer arrestors shall be certified to the PDI WH-201 Standard and ASSE Standard 1010.

B. Arrestors shall be designed and manufactured for a maximum working temperature of 250F and maximum operating pressure of 125 P.S.I.G.

C. All arrestors shall be designed and approved for sealed wall installation without an access panel.

D. Water hammer arrestors shall be sized according to water hammer arresters standard PDI-WH-201 and as indicated on Contract Drawings.

2.11 WALL HYDRANTS

A. Provide antisiphon, non-freeze wall hydrant with brass casing, integral backflow preventer, vandal proof box with loose-key handle and finish as scheduled on Drawings.

B. Hose Bibbs (HB): Provide Chicago Faucet No. 387 chrome plated brass hose bib with ¾-inch female inlet, wall flange and No. E27 vacuum breaker.

2.12 FLOOR DRAIN TRAP SEAL GUARDS

A. Floor drain trap seal protection insert shall provide watertight seal inside the floor drain and prevent emission of sewer gas and backup of sewage.

B. Insert material shall be resistant to common cleaning solutions, lime scale and microbiological growth and incorporate an Elastomeric flexible tube that closes when water is not passing through and opens to permit water flow from an intermittent drip. Insert shall provide no restriction on water flow up to 30 gallons per minute.

C. Insert shall properly functions despite lodging of common debris such as mop strings, food residue, etc.

D. Trap seal protection insert shall not be installed in floor drains receiving waste that may have a temperature greater than 140 degrees F.

E. Trap seal protection insert shall not be installed in floor drains receiving waste discharge flow of greater than 30 gallons per minute.

F. Trap seal protection insert shall not be installed in floor drains receiving corrosive or chemical waste.

G. Trap seal protection insert shall be manufactured by ProSet "Trap Guard", model to suit installation.

2.13 TRAP PRIMER UNITS (TP)

A. Automatic Pressure Activated Trap Primers:

1. Pressure drop activated brass trap seal primer, with O-ring seals, inlet opening of 1/2" male N.P.T. and outlet opening of female 1/2" N.P.T. Complete with four view holes and removable filter screen.
2. ASSE 1018 tested and certified, IAPMO listed, activate by line pressure drop of 3 psi at an operating range of 20 to 125 psi.
3. Provide each trap primer unit with a copper air gap fitting complete with a 1/2” male N.P.T. fitting at the inlet supply incorporating a stream directing nozzle, a 1/2” N.P.T. female outlet, and a 1” vertical air gap. Manufactured in accordance with ANSI/ASME A112.1.2 air gap in plumbing systems standard.
4. Provide distribution unit as required.

B. Vacuum Breaker Trap Primer for use with exposed Flushometers:

1. One Piece, Chrome Plated Flush Connection.
2. Water Deflector to control the amount of water diverted from the flush.
3. 3/8” Elbow and Flex-bend Tube connection from Vacuum Breaker to wall.
4. Diverter Wall Flange and Fittings
5. Chrome Plated Wall Flange and Fitting to connect ½” NPT pipe.
6. High Back Pressure Vacuum Breaker.
7. One-piece Bottom Hex Coupling Nut.
8. Sloan Model VBF-72-A1

C. Trap Primer for use with Lavatory or Sink Drain Tailpiece:

1. Polished Chrome Plated Cast Bronze P-trap with Ground Joint Outlet.
2. Threaded Wall Tube, Slip Joint Nuts, Washers and Escutcheons.

3. 1/2" Polished Chrome Plated Bronze Primer Tube with Compression Fitting Connection at Wall.

4. Jay R. Smith Model 2698 or approved equal of a referenced acceptable manufacture.

2.14 STRAINERS

A. Strainers, 2" and smaller, bronze body, screwed ends, No. 20 mesh type 304 stainless steel screen, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap).

B. Strainers, 2 1/2" and larger, cast iron body, isolating type flanged ends where installed in copper lines, .125” perforated type 304 stainless steel screen, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap). Special Note: All strainers 6" and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap. Baskets for strainers 6" and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.

2.15 TEMPERATURE GAUGES:

A. Thermometers shall be vapor or liquid actuated, direct-mounted, universal adjustable angle dial type with stainless steel or cured polyester powder coated cast aluminum case, stainless steel friction ring and glass window. Dial face shall be white with black figures; pointer shall be friction adjustable type. Movement shall be brass with bronze bushings. Bourdon tube shall be phosphor bronze with a brass socket.

B. Thermometer range shall be 30 - 240° Fahrenheit and have an accuracy of ±1 scale division.

C. Dial face shall be 4½” diameter where installed within six feet of floor level and 6” diameter where installed higher than six feet above floor level. Provide remote read-out gauges for isolated or hard to access monitoring points.

D. Provide a brass or stainless steel separable thermowell for each thermometer.

E. Thermometers shall have a sensing bulb with an insertion length of roughly half of the pipe diameter; minimum insertion length shall be 2". Thermometers installed on tanks shall have a minimum insertion length of 5".

F. Where insulation thickness exceeds 2", provide proper bulb length and an extension neck separable thermowell. The extension neck shall be at least 2" long.

2.16 PRESSURE GAUGES:

A. Gauges shall comply with ASME B40.1, Grade 2A, and have ±0.5 percent of full scale accuracy, with type 304 stainless steel or aluminum case, bronze wetted parts and brass socket. Dial face shall be 3½” diameter where installed within six feet of floor level and 6” diameter where installed higher than six feet above floor level. Dial face shall be aluminum with white background, black graduations and black markings. Pointer shall be adjustable with black finish. Provide remote read-out gauges for isolated or hard to access monitoring points.

B. Units of measure shall be in pounds per square inch (psi). The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.

C. All pressure gauges shall be equipped with brass or stainless steel needle valves and pressure snubbers.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains with General Contractor.

B. Verify location of equipment and housekeeping pads prior to installation of floor drains. Relocation due to misplacement shall be at Contractor’s expense.

C. The size of equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space.

D. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

E. Space Requirements:

F. Provide access and clearance space around equipment for future maintenance work according to the manufacturer’s recommendations.

G. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Install plumbing specialties in accordance with manufacturer’s published instructions.

C. Extreme care shall be used to set the top elevation of floor drains and floor sinks to meet the low point elevation of the finished floor.

D. Pipe connections to roof drains, above grade floor drains and floor sinks shall not directly contact or be encased in concrete.

E. Final mounting of interior cleanout top or access cover shall be set flush with the finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil.

F. Encase exterior cleanouts within 14” x 14” x 6” thick reinforced concrete pad. Set top flush with finished grade surface.

G. Locate cleanouts with required clearance for rodding of drainage system.

H. Isolate all non-potable water requirements from the building domestic water system with backflow prevention device manufactured and certified for the particular application.

I. Pipe relief from backflow preventer indirectly to drain of sufficient size to evacuate discharge.

J. Backflow preventers shall be duplexed where located within domestic water lines serving in-patient areas, critical research areas, and/or any area or equipment where un-interruptible (24 hour) water service is required.

K. Provide hydraulic shock absorbers in cold and hot water supply lines to each fixture branch, battery of fixtures and at each automatic, solenoid-operated or quick-closing valve serving equipment. Locate and size in accordance with PDI-WH-201 Standard and manufacturer’s published recommendations.

L. Provide ball type shut-off valve and union directly upstream of each line pressure activated trap primer unit to allow service.

M. Locate all trap primers exposed and accessible.

3.03 TESTING

A. Pressure Testing – Apply a hydraulic pressure at 150% of the normal operating pressure or 100 psi, whichever is greater not to exceed the working pressure rating of the lowest pressure rated component in the system (i.e. threaded components, flanges, unions, valves, etc.) for a minimum of 2 hours to carefully check all piping and every fitting for leaks. Repair each leak and retest until no leaks occur. Refer to other Division 22 specifications for additional and/or different pressure testing requirements for a specific plumbing related piping system. Reduced test pressures must be used for any elevated temperature testing due to field conditions affecting temperatures. Appropriate temperature de-rating factors must be applied to determine a suitable test pressure at elevated temperatures (>73°F).

B. Schedule 80 PVC pipe Testing:

C. WARNING – Air or compressed gas shall never be used for pressure testing. Use of compressed air or gas in PVC or CPVC pipe and fittings can cause explosive failures resulting in system damage, severe bodily injury or death.

D. Hydrostatic pressure testing (testing with water filled lines) is the only test method recommended and approved for pressure testing PVC and CPVC piping products. During pressure testing appropriate safety precautions must be taken to protect personnel and property from damage should a failure occur. Plastic pipe is not designed to provide structural strength beyond sustaining internal pressures up to its designed hydrostatic pressure rating and normal soil loads. Anchors, valves, and other connections must be independently supported to prevent added shearing and bending stresses on the pipe. The test pressure and duration of the pressure test performed should meet requirements of any local, state, or federal regulations as applicable. In the absence of any such requirements or regulations the following procedures can be used to properly conduct a hydrostatic pressure test on newly installed PVC and CPVC piping systems.

E. Strict adherence to proper solvent cementing instructions and set and cure times is essential to ensure the highest system integrity prior to pressure testing. Particular attention should be paid to pipe sizes, temperature at time of installation and any temperature variations over the set and cure period.

F. All solvent-cemented connections in the system must be fully cured properly prior to filling the system with water.

G. Pipe must be adequately anchored/restrained to prevent movement during testing.

H. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so provided that Contractor properly supervises the operation and has the Owner's written permission to do so. The warranty period shall not start until the date of Substantial Completion, however.

I. Regardless of whether or not the equipment has been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before Substantial Completion. The date of acceptance and performance certification will be the same date.

J. Check inspections shall include piping, equipment, insulation, controls, wiring and such other items and systems components hereinafter specified or specifically designated by the Architect/Engineer.

K. The Contractor shall execute at no additional cost to the Owner any tests required by the Uniform Plumbing Code, ASTM, or other standards listed above. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests which follow Substantial Completion will be borne by the Owner.

L. Notify the Owner's Project Manager and the Architect/Engineer in writing at least seven (7) calendar days prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.

M. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results and other pertinent data. The data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.

N. Refer to the Commissioning Specification Sections for additional start-up, pre-functional and operational checkout, and for functional performance test procedures.

O. Any pneumatic testing needs to be coordinated with UT EHS and all associated safety personnel to coordinate testing conditions and safety items as well asobtain approval prior to testing.

3.04 TRAINING

A. Operation and Maintenance Manuals and instruction shall be provided as specified under Division 01.

B. Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

3.05 PIPE PRESSURE TEST

A. The following lines shall be tested at the stated pressure for the length of time noted. Pressure gauges used should have a range no greater than 50 % over test pressure. The values below are guidelines. Codes and field conditions will be used by the PSP to verify the validity of numbers below.

SERVICE	MEDIUM	TESTING PRESSURE (PSIG)	TESTING TIME
Chilled Water	Water	125***	2 hours
Steam (Low pressure & steam condensate)	Water	60	2 hours
High-Pressure Steam	Lab Water	225	2 hours
Domestic Hot & Cold Water*	Water	125	30 minutes
Low Pressure Natural Gas	Air	30	30 minutes
Medium Pressure Natural Gas	Air	60	2 hours
Sanitary, Storm, Waste, Vent	Water	10-foot head	2 hours
Or	Air	5	24 hours
Piped Vacuum System	Nitrogen	60	2 hours

Compressed Air*	Air	125	2 hours
DI Water (Lab Water)	Water	60*	2 hours
Medical Gasses*	Nitrogen	150	24 hours
Sprinkler and Fire System Main	Water	200	2 hours
Dry Pipe Fire System	Water	200	24 hours

* Or 150 % of Working Pressure; whichever is greater

** Welded Steel pipe (Adopted 4/27/2007)

*** Main chilled water loop testing pressure 150% of design pressure, minimum test pressure 225 psig

NOTE: Use of air or nitrogen as the testing medium shall require specific testing procedures due to the high hazard potential.

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SECTION 22 01 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for medical plumbing fixtures. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the products manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

1.02 SUMMARY

A. This Section includes the following medical plumbing fixtures and related components:

1. Faucets for lavatories, showers, and sinks.
2. Laminar-flow, faucet-spout outlets.
3. Flushometers.
4. Toilet seats.
5. Protective shielding guards.
6. Fixture supports.
7. Bedpan washers.
8. Water closets.
9. Lavatories.
10. Individual showers.
11. Patients' combination toilets.
12. Clinical sinks.
13. Plaster sinks.
14. Surgeons' scrub sinks.
15. Surgeons' instrument sinks.
16. Bathing units.
17. Sitz baths.
18. Bedpan washing equipment.
19. Hydrotherapy whirlpools.
20. Outlet boxes.
21. Morgue equipment.

1.03 DEFINITIONS

A. Accessible Medical Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

1.04 SUBMITTALS

A. Product Data: For each type of medical plumbing fixture indicated.

B. LEED Submittal:

1. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Operation and maintenance data.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act", **as directed**; for plumbing fixtures for people with disabilities.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

2. Plastic Bathtubs: ANSI Z124.1.

3. Plastic Shower Enclosures: ANSI Z124.2.

4. Slip-Resistant Bathing Surfaces: ASTM F 462.

5. Vitreous-China Fixtures: ASME A112.19.2M.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
2. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
3. Faucets: ASME A112.18.1.
4. Hose-Connection Vacuum Breakers: ASSE 1011.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
7. NSF Materials: NSF 61.
8. Pipe Threads: ASME B1.20.1.
9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
10. Supply Fittings: ASME A112.18.1.
11. Brass Waste Fittings: ASME A112.18.2.

H. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Flexible Water Connectors: ASME A112.18.6.
4. Manual-Operation Flushometers: ASSE 1037.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
6. Brass Waste Fittings: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Grab Bars: ASTM F 446.
2. Hose-Coupling Threads: ASME B1.20.7.
3. Off-Floor Fixture Supports: ASME A112.6.1M.
4. Pipe Threads: ASME B1.20.1.
5. Plastic Toilet Seats: ANSI Z124.5.
6. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

A. Single Bowl Sinks:	Elkay LRAD 1716
B. Double Bowl Sinks:	Elkay LRAD 3322
C. Lab Sink	Labtops D55 (IC#8008)
D. Lab Sink	Labtops A55 (IC#8007)
E. Eyewash:	WaterSavers EW805LH
F. Water Closets:	Kohler K-4330
G. Urinals:	Kohler K-4989-T
H. Lavatories:	Kohler K-2032
I. Cast Iron Bathtubs:	American Standard, Kohler, Crane, Eljer
J. R.O. Faucets:	Marquest LG-DD-R1
K. D.I. Faucets:	Marquest LG-DD1MO-R1
L. Touchless Lab Faucets:	Sloan EBF-750-S-H-8
M. Touchless Lavatory Faucets:	Sloan EAF-150-ISM
N. Lab and Kitchen Faucets:	Chicago Faucets 786-CP
O. Shower	Chicago Faucets 1762
P. Floor Drain	ProFlo PFFW93B
Q. Safety Shower	HAWS 8123HPCP
R. Safety Shower/Eyewash	HAWS 8309PCP

PART 3 - EXECUTION

3.01 INSTALLATION

A. Assemble medical plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install shower flow-control fittings with specified maximum flow rates in shower arms.

N. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

O. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results For Plumbing".

P. Set showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results For Plumbing".

Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants".

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 14 Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from domestic water piping to medical plumbing fixtures.

C. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.

D. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".

E. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

3.03 FIELD QUALITY CONTROL

A. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.

B. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed medical plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.04 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning medical plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.05 CLEANING

A. Clean medical plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

   2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.06 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of medical plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 01 40 00

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SECTION 22 05 13 00 COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes general requirements for 1-phase and 3-phase electric motors with NEMA frame machines sized through 200 horsepower and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation. Unless otherwise specified, provide motors meeting the basic requirements for general purpose alternating current motors, as defined in ANSI / NEMA MG 1-1.05.

B. All motors provided with Division 22 equipment shall meet the provisions of this specification.

C. Refer to the appropriate Division 26 specifications for specific electrical requirements, which are not generally specified within this section.

D. This section pertains to building level motors serving plumbing equipment.

1.02 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

1.03 STANDARDS

A. Motors shall be designed, built, and tested in accordance with the latest revision of the following standard documents.

1. NEMA MG 1 - Motors and Generators.
2. ANSI / IEEE 112 - Test Procedures for Motors / Generators.
3. UL 1004 - Motors, Electric.
4. UL 674 - Motors, Generators, Electric, for Use in Hazardous Locations: Class I, Groups C and D; Class II, Groups E, F, and G.
5. The latest Texas State Energy Commission (SECO) adopted version of AHSRAE 90.1, or IECC.
6. National Electric Code (NEC).

1.04 WARRANTIES

A. The minimum University of Texas Uniform General Conditions (UGC) warranty requirements apply from the date of final acceptance of the equipment, which is the date that the University assumes operation of the unit. This does not negate any additional manufacturer's warranty. The Vendor shall provide the standard form of written guarantee and warranty covering defects in materials and workmanship.

1.05 SUBMITTALS

A. Provide the following information for each motor:

1. Manufacturer.
2. Rated full load horsepower.
3. Rated volts.
4. Number of phases.
5. Frequency in hertz.
6. Full load amperes (FLA).
7. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.
8. Nominal speed at full load (rpm).
9. Service factor.
10. NEMA design letter.
11. NEMA machine type (ODP, WP-I, TEFC, etc).
12. Motor space heater voltage, wattage and number of wires (where applicable).
13. Certified motor outline dimensions, weight, and frame number. Include lifting points, location of accessories, and center of gravity.
14. List of recommended start-up and spare parts for each motor, including bearings and shaft grounding system as appropriate to motor use.

B. For motors 3/4 horsepower and larger, include the following additional information:

1. NEMA frame size.
2. NEMA insulation system classification. For motors required to be installed outdoors, include information showing compliance with the intent of paragraph 2.3C.
3. Maximum ambient temperature for which motor is designed.
4. Time rating.
5. Bearing type.
6. Efficiency at full load.

C. For motors 20 horsepower and larger, include the following additional information:

1. No load amperes.
2. Efficiency at 1/2 and 3/4 load.
3. Power factor at no load, 1/2, 3/4 and full load.
4. Full load amperes.
5. Maximum guaranteed slip at full load.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. ABB/Baldor/Reliance

B. General Electric

C. Toshiba

D. TECO Westinghouse

E. Century Electric

2.02 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in Plumbing equipment schedules or a specific equipment specification section.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. The driven load for constant speed applications shall not exceed the motor's continuous nameplate rating, exclusive of any service factor, under any normal operating condition.

D. Efficiency: Provide motors meeting the energy efficiency and power factor requirements of the latest, SECO adopted version of ASHRAE 90.1 or IECC.

E. Motors Less Than 1/2 Hp

  1. Motors less than 1/2 hp shall be squirrel-cage, induction type, capacitor start with copper stator windings.

  2. Power Requirements: 115 V, single phase, 60 Hz.

  3. Service Factor: 1.15

F. Motors Larger Than 1/2 Hp Through 250 Hp

  1. Motor Type: Motors shall be NEMA design letter B, 3-phase, continuously rated, squirrel-cage, random-wound copper, induction motors

  2. Power Requirements: 460 V, three phase, 60 Hz.

  3. Service Factor: 1.15

G. Insulation: Provide motors with Class F insulation meeting NEMA MG 1 Part 31.

H. Temperature Rise: Provide motors with class B temperature rise based on 40 degrees C ambient. When ambient temperatures exceed 40 degrees C, temperature rise shall be adjusted according to NEMA MG 1-12.

I. Locked Rotor Current: Provide motors with locked rotor starting currents not exceeding Code L under 3 hp, Code K for 3 and 5 hp, Code H for 7-1/2 and 10 hp, and Code G for 15 hp and above.

J. Bearings: Provide all motors with sealed anti-friction grease lubricated ball bearings, with a bearing ABMA L-10 life of 100,000 hours. Provide factory lubrication of all motors prior to shipment. Provide all grease-lubricated bearings with relief fittings.

K. Motor Heaters: Motors which are located outside or wherever specified shall be provided with space heaters sized to prevent moisture condensation, rated 120 volts, with a separate conduit box for heater leads only.

L. Thermal overload protection: For motors 5 horsepower and larger, provide a snap action normally closed Klixon thermal circuit breaker embedded in the stator winding at the 12:00 position with tee leads wired out to the wiring compartment. The temperature of the Klixon shall be set for 25% of the insulation temperature rating above ambient.

M. Motors used with variable frequency drives:

1. NEMA Standard MG 1 definite purpose inverter duty rated motors shall be used for all variable frequency drive installations. The inverter duty motors shall be able to withstand voltages greater than 1600 volts peak and rise times of 0.1 microsecond.

2. On applications where the motor specification does not meet NEMA MG 1 Part 31 (1600V peak and 0.1 microsecond rise time), and the cable length between the inverter and motor exceeds the drive manufacturer recommended maximum cable length, provide load sideline reactors. The load sideline reactors shall be design and constructed to operate with variable frequency inverter drives with switching frequencies up to 20 Khz. Line reactor insulation dielectric strength shall be greater than or equal to 4000 volts and shall carry a UL506 & UL508 approval.

3. A shaft grounding system on the drive end of the motor shall be used for all inverter duty rated motors.

4. Inverter duty motors shall be constructed with triple film wire, increased winding slot insulation, increased insulation between phases, and increased first turn insulation. The inverter duty motor shall use slot fillers as required to avoid loose windings.

5. The inverter duty motor nameplate shall indicate that the motor is an inverter duty motor.

2.03 ELECTRONICALLY COMMUTATED MOTORS

A. The Motor Speed Controller shall be integral with the motor, sized and matched for motor by the motor manufacturer. Motor speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0- 10 VDC signal. Motor shall be controllable down to 20% of full speed.

B. Motors shall be permanently lubricated with heavy duty ball bearings.

C. Provide all transformers and wiring factory mounted for a completely functional unit.

D. Motor shall be a minimum of 75% efficient at all speeds.

2.04 MOTOR TYPES

A. The following standard motor types shall conform to the following requirements. If not otherwise scheduled or specified, provide open drip proof type motors.

1. Open Drip Proof: Provide motors with an enclosure that meets NEMA Standard MG 1 for open, drip proof (ODP) construction. Provide screen over all air openings.

2. Totally Enclosed Fan-Cooled: Provide totally enclosed fan-cooled (TEFC) motors with frame sizes 182 and larger with cast iron frames and end shields. Smaller frame sizes may be constructed of rolled steel with cast metal end shields. Provide motors with condensate drain holes. For frame size 286 and larger, provide automatic breather/drain device in drain hole.

3. Vertical Weather Protected Type I: Provide vertical motors with an enclosure that meets NEMA Standard MG 1 for weather protected Type I (WP-I) enclosure. Provide screens over all air openings.

4. Explosion proof: Provide all horizontal and vertical motors with TEFC explosion proof enclosures, UL listed for Class 1, Division 1, Group D hazardous atmosphere.

5. Submersible: Submersible motors UL listed for explosion proof atmospheres in accordance with subsequent sections of this specification. In addition, provide submersible motors with two mechanical seals; the lower one outside the motor and protecting the upper one, which is in an oil filled chamber. Provide moisture detector probes in the oil filled seal chamber to indicate the presence of moisture in the seal chamber. Provide a temperature detector and switch rated 3 amperes, 120 volts minimum, set to operate when the internal motor temperature exceeds a preset limit. Provide any relays or solid-state controls for separate mounting.

6. Totally Enclosed, Fan-Cooled, Severe Duty: Provide severe duty TEFC motors suitable for contaminated environments, including gasketed conduit box, stainless steel drains, double-shielded bearings, and corrosion resistant paint.

2.05 MOTOR STARTERS

A. Refer to Division 26 specifications for motor starter requirements.

2.06 HARDWARE

A. Use structural bolts, washers, nuts, pins, and similar items manufactured of high-strength steel. Use only hexagon-head bolts and hexagon nuts.

B. Use corrosion-resistant materials or protect hardware from corrosion by hot-dip galvanizing, chrome plating, or cadmium plating.

2.07 NAMEPLATES

A. Main Nameplate: Provide each motor with a stainless steel nameplate meeting the requirements of NEMA MG 110.38, and the National Electrical Code, Section 4307. Identify energy-efficient motors in accordance with MG-1-12.54.2.

B. Bearings Nameplate: When bearings are oil lubricated, include oil type information on a suitable nameplate. Indicate bearing data if nonstandard.

C. Attachment: Attach the nameplates to the motor with stainless steel fastening pins or screws.

2.08 CONDUIT BOX

A. Provide motors with conduit boxes that are fully rotatable, diagonally split, including gasket between cover and box, and box and frame, with threaded hubs and a grounding lug located within the box for ground conductor connection. Conduit boxes shall be suitably sized for the motor lead terminations, in accordance with the National Electrical Code, Section 430-12.

2.09 PAINT

A. Manufacturer's standard shop paints for prime and finish coats are acceptable.

2.10 NOISE

A. Provide integral horsepower motors with overall sound power levels meeting the requirements of MG 1-12.49.

2.11 LEADS

A. Use not less than ASTM B 173, Class G, stranded copper conductors with insulation the same as or better than specified in the preceding Motor Insulation paragraph.

B. Provide permanent identification numbers on leads according to NEMA MG 12.02.

C. Use crimp-on, solderless copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Properly install and align motors in the locations as shown on Drawings. Use crimp-on, solderless copper terminals on the branch circuit conductors. For motors 20 horsepower and larger, use 3M 5300 Series motor lead splicing kit or approved equivalent.

B. Nameplate must be in full view when motor and equipment are installed.

C. If a motor horsepower rating larger than indicated is offered as a substitute and is accepted, provide required changes in size of conductors, conduits, motor controllers, overload relays, fuses, circuit breakers, switches, and other related items at no change in contract price.

3.02 FIELD TESTING

A. Provide instruments, labor and personnel required to perform motor inspection and testing.

B. Inspect all motors for damage, moisture absorption, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification, and cleanliness. Report abnormalities to Owner’s Representative before energizing.

C. Test the electrical wire insulation resistance (IR, or Megger Test) for all motors 20 horsepower and larger in accordance with IEEE Report No. 43, “Recommended Practices for testing Insulation Resistance of Rotating Machinery” to determine insulation resistance.

D. Measure full load current and full load voltage.

E. Complete and submit Motor Test Report forms to Owner’s Representative.

F. After installation has been thoroughly checked and found to be in proper condition with thermal overloads in motor controllers properly sized and all controls in place, energize the equipment at system voltage for operational testing.

3.03 PUMP MOTOR REQUIREMENTS

A. Connect all pump motors rated at 25 amps or below with a flexible power cord no longer than 3 feet. The cord shall be hard service SO cord, rubber insulated with a neoprene jacket, rated at 90° C, 600V, oil resistant. The cord shall be sized for the motor nameplate amperage.

END OF SECTION 22 05 13 00

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SECTION 22 05 23 00 – GENERAL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Refer also to the General Requirements Division 01 Specification Sections included in this contract.

B. Refer also to all other Division 22 Specification Sections included in this contract.

1.02 SUMMARY

A. This section provides requirements for furnishing and installing valves within the following systems: domestic water, non-potable water, sewage, makeup water, compressed air, vacuum, and natural gas.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. Uniform Plumbing Code.
2. NSF/ANSI 61: Drinking Water System Components - Health Effects.
3. NSF/ANSI 372: Drinking Water System Components – Lead Content.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

1.04 QUALITY ASSURANCE

A. Manufacturer’s name and pressure rating shall be permanently marked on valve body.

B. The Contractor shall follow the valve manufacturer’s installation instructions.

C. Protect all piping, valves, fittings, etc. before installation in accordance with manufacturer’s written instructions.

D. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section.

E. Solder connected or press type fittings and valves shall conform to ASMEB16.51, NSF61G, FM Class 1920 and CSA MSE-13. Solder connected or press type fittings and valves are approved for use on domestic water up to 4” in size, compressed air (125 psi Max) and Vacuum (29.2” Hg @ 68^0F). All other utility services will require written prior approval.

F. Installer Qualifications:

1. Company shall have minimum three years documented experience specializing in performing the work of this section.
2. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of

Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

3. All installers of copper press fittings and valves shall be trained by the fitting manufacturer's appointed representative. Written notification of training shall be submitted to Owner prior to any installation. All press type system components shall be strictly of the same manufacturer.

G. All grooved joint couplings, fittings, flanges, valves, and specialties of the same type shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as grooved components. All installers of copper grooved fittings shall be trained by the fitting manufacturer's appointed representative,

1.05 SUBMITTALS

A. Product Data:

1. Code and Standards compliance, manufacturer's data for fittings, valves and all other products included within this specification section.

2. Operation and Maintenance Data: installation instructions, maintenance requirements, exploded assembly views, replacement part numbers, location and contact information for the local parts supplier.

3. Grooved joint valves, couplings and fittings shall be specifically identified with the applicable style or series designation.

B. Record Documents:

1. Field locations of valves and access panels

2. Valve charts.

3. Test reports and inspection certifications for all systems.

4. Valve manufacturer’s warranties.

1.06 DELIVERY, STORAGE and HANDLING

A. See Specification 22 00 00, Basic Plumbing Requirements.

PART 2 - PRODUCTS

2.01 VALVES:

A. All valves in domestic water systems shall be lead free.

B. All valves must be threaded or flanged. Do not use solder connected or press fitting type valves.

C. Do not mix different manufacturers of one valve type on the same project. i.e. all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacturer, etc.

D. All valves shall be Class 150 and shall be constructed according to ASTM B61. All gate, globe and angle valves shall be the union bonnet design and the stems shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Alloys used in valves shall contain no more than 15% zinc. Yellow brass valves are not allowed.

E. Acceptable manufacturers: Apollo, Kitz, Nibco, Stockham, Milwaukee, Rockwell, DeZurik and Mueller.

F. All forged steel body valves shall have the pressure containing parts constructed of ASTM 105, Grade 2 forged carbon steel. Seat and wedges shall meet ASTM A-182-F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI B16-34 pressure-temperature rating.

G. All valves shall be repackable, under pressure, with the valve in the full open position. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

H. All valve stem packing shall be high quality, asbestos free, and selected for the pressure-temperature service of the valve. Spot checks may be made within the warranty period. If the packing shows signs of failing then the contractor shall repack all valves supplied by the contractor with a packing material selected by the owner at no expense to the owner.

I. Valves 12" and larger located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 to accommodate a drain valve and equalizing by-pass valve assembly.

J. Balancing and/or Shutoff Valves for Domestic Cold Water and Hot Water Systems for 2-1/2” and smaller: ball valve, two piece, full port, FNPT x FNPT, bronze body, stainless steel ball and stem, teflon seats, packing and gasket, plastic sheathed steel lever type handle, class 150 SWP/600 WOG. Stem extensions shall be furnished for use in insulated lines or provide insulated handle system Nib-seal or equal. Acceptable manufacturers: Apollo, Milwaukee, Nibco.

K. Balancing and/or Shutoff Valves for Domestic Cold Water and Hot Water Systems for 3" and larger: butterfly valve, tapped full lug style, aluminum bronze discs of ASTM B148 Alloy C955 and 316, 416, or 420 stainless steel shafts. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling. Valve must be capable of providing a bubble tight seal at 200 psi for valves up to 12" (150 psi for larger valves) when used for end of line service without requiring the installation of a blind flange on the downstream side. Liners shall be resilient material suitable for 225 °F temperature and bodies of ductile iron. Butterfly valves 8" and larger and butterfly valves used for balancing service, regardless of size, shall have heavy duty weather proof encased gear operators, with malleable iron hand wheel or crank. Valves 3" through 6" shall have lever handles which can be set in interim positions between full open and full closed. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi.

L. Check Valves for Water Systems: Bronze body, 2" and smaller, bronze body regrinding disc and seat with screw-in cap. Iron body, 2 1/2" and larger, bronze disc and seat or non-slam wafer type with stainless pins and springs, and bronze plate. Forged steel lift check valves, 2" and smaller shall be bolted cap and body, screwed end connections and conform to ANSI B16.34 and pressure temperature rating.

M. Gate valves 2 1/2” and larger shall have approved rating of 175 psi WWP or greater, iron body with resilient rubber encapsulated wedge, epoxy-coated interior, and pre-grooved stem for supervisory switch.

N. Standards of Quality for Valves:

Size	Type	Service	Class	Milwaukee	Nibco	Stockham, or as noted
2-1/2" & larger	Globe, Angle & Balancing	Plumbing	150	F-2981	F-718-B	G-514-T
3" & larger	Butterfly	Domestic Hot & Cold Water Systems Shutoff	150	NE-C,NF	LD2000	DeZurik 632, L,D, RS66,6
2-1/2" & smaller	Check Valve	All Water Systems	150	510	T-433-Y-LF	B-345
3" & larger	Check Valve	All Water Systems	150	1400	W-920-W-LF	Stockham Duo-Check Series
3" to 12"	Mechanical Joint Ends – Gate Valve (ANSI/AWWA C515)	(below ground)	150	--	--	Mueller A-2361-20
1-1/2" & smaller	Lubricated Gas Cock	Natural Gas	150	BB2-100	--	Rockwell 1796 & 142 With Wrench
2" & larger	Lubricated Gas Cock	Natural Gas	150	--	--	Rockwell 1797 & 143 With Wrench
2" & smaller	Isolation Ball Valve	Medical & Lab Gases	150	BA-350-TE	CS-595-YX	--

*Requires extended stems in insulated lines with adjustable memory stop.

1. Valves 8" and larger, and valves used for balancing service regardless of size, shall have heavy-duty weatherproof encased gear operators.

2.02 UNIONS

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus. Unions in 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2" and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type equal to Epco.

C. In all water lines where the material of the pipe is changed from ferrous to copper or brass, a dielectric coupling shall be used at the transition.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. All valves must be installed true, straight, easily visible and accessible, and such that the removal of their bonnets is possible. Install horizontal valves such that the stem is oriented between 9 o'clock and 3 o'clock.

C. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be indicated on the Record Drawings.

D. Provide clearance for access to valves, fittings and equipment for operation and maintenance.

E. Install chain wheels on operators for butterfly gate NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor.

F. Provide valve vaults or boxes to provide access to valves installed below grade.

3.03 ISOLATION VALVES

A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving equipment, and at other locations as indicated and required for isolation of piping or equipment. Main riser branch connection valves shall be located for maintenance personal access and operation.

3.04 DRAIN VALVES AND VENTS

A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained. Install 2 inch drain for 2 inch pipes and larger. Install a line size drain valve for pipes smaller than 2 inches.

B. Install a line size drain valve for pipes smaller than 2 inches.

C. Provide hose adapter and cap on all drain lines.

D. Provide automatic vents with isolation valves or manual vents at locations as indicated on Drawings and all high points in piping systems.

3.05 TESTING

A. See Specification 22 00 00, Basic Plumbing Requirements.

B. Remove or isolate valves, expansion joints, strainers, and equipment that are rated at pressures less than test pressure.

C. Repair all leaks and retest the system until proven leak tight.

END OF SECTION 22 05 23 00

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SECTION 22 05 76 00 - SANITARY SEWERAGE

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for sanitary sewerage. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.02 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure and pressure couplings.
3. Expansion joints and deflection fittings.
4. Backwater valves.
5. Cleanouts.
6. Encasement for piping.
7. Manholes.

1.03 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.04 SUBMITTALS

A. Product Data: For the following:

1. Expansion joints and deflection fittings.
2. Backwater valves.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Profile Drawings: Show system piping in elevation. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet (1:500) and to vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

E. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

F. Field quality-control reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the University no fewer than two days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without The University written permission.

PART 2 - PRODUCTS

2.01 GENERAL

A. Hub-And-Spigot, Cast-Iron Soil Pipe and Fittings

1. Pipe and Fittings: ASTM A 74, Service class **OR** Service and Extra-Heavy classes **OR** Extra-Heavy class, **as directed**.

2. Gaskets: ASTM C 564, rubber.

3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

B. Hubless Cast-Iron Soil Pipe and Fittings

1. Pipe and Fittings: ASTM A 888 or CISPI 301.

2. CISPI-Trademark, Shielded Couplings:

a. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

3. Heavy-Duty, Shielded Couplings:

a. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

4. Cast-Iron, Shielded Couplings:

a. Description: ASTM C 1277 with ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

5. Unshielded Couplings:

a. Description: ASTM C 1277 and ASTM C 1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Ductile-Iron, Gravity Sewer Pipe and Fittings

1. Pipe: ASTM A 746, for push-on joints.

2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

3. Compact Fittings: AWWA C153, ductile iron, for push-on joints.

4. Gaskets: AWWA C111, rubber.

D. Ductile-Iron, Pressure Pipe and Fittings

1. Push-on-Joint Piping:

   a. Pipe: AWWA C151.

   b. Standard Fittings: AWWA C110, ductile or gray iron.

   c. Compact Fittings: AWWA C153.

   d. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.

2. Mechanical-Joint Piping:

   a. Pipe: AWWA C151, with bolt holes in bell.

   b. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.

   c. Compact Fittings: AWWA C153, with bolt holes in bells.

   d. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.

   e. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

E. Nonpressure-Type Transition Couplings

1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

2. Sleeve Materials:

   a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.

   b. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.

   c. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

   d. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

   e. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Unshielded, Flexible Couplings:

   a. Description: Elastomeric sleeve, with stainless-steel shear ring, **as directed**, and corrosion-resistant-metal tension band and tightening mechanism on each end.

4. Shielded, Flexible Couplings:

   a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Ring-Type, Flexible Couplings:
    a. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
6. Nonpressure-Type, Rigid Couplings:
    a. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

F. Pressure-Type Pipe Couplings

1. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.
2. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig (1035-kPa) **OR** 200-psig (1380-kPa), **as directed**, minimum pressure rating and ends of same sizes as piping to be joined.
3. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
4. Gasket Material: Natural or synthetic rubber.
5. Metal Component Finish: Corrosion-resistant coating or material.

G. Expansion Joints and Deflection Fittings

1. Ductile-Iron, Flexible Expansion Joints:
    a. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
2. Ductile-Iron Expansion Joints:
    a. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
3. Ductile-Iron Deflection Fittings:
    a. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.

H. Backwater Valves

1. Cast-Iron Backwater Valves:
    a. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
    b. Horizontal type; with swing check valve and hub-and-spigot ends.
    c. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.

d. Terminal type; with bronze seat, swing check valve, and hub inlet.

2. PVC Backwater Valves:

   a. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

I. Cleanouts

1. Cast-Iron Cleanouts:

   a. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

   b. Top-Loading Classification(s): Light Duty **OR** Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty, **as directed**.

   c. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

J. Encasement for Piping

1. Standard: ASTM A 674 or AWWA C105.

2. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) **OR** high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.

3. Form: Sheet **OR** Tube, **as directed**.

4. Color: Black **OR** Natural, **as directed**.

K. Concrete

1. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:

   a. Cement: ASTM C 150, Type II.

   b. Fine Aggregate: ASTM C 33, sand.

   c. Coarse Aggregate: ASTM C 33, crushed gravel.

   d. Water: Potable.

2. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.

   a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.

   b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

3. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

   a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

1) Invert Slope: 1 **OR** 2, **as directed**, percent through manhole.

b. Benches: Concrete, sloped to drain into channel.

1) Slope: 4 **OR** 8, **as directed**, percent.

4. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.

a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.

b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.01 EXECUTION

A. Earthwork

1. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

B. Piping Installation

1. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

5. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

6. Install gravity-flow, nonpressure, drainage piping according to the following:

a. Install piping pitched down in direction of flow, at minimum slope of 1 **OR** 2, **as directed**, percent unless otherwise indicated.

b. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.

c. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.

d. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."

e. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."

f. Install ductile-iron, gravity sewer piping according to ASTM A 746.

g. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.

h. Install PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 1668.

i. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.

j. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.

k. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.

l. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

m. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.

n. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

o. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

7. Install force-main, pressure piping according to the following:

a. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.

b. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.

c. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.

d. Install ductile-iron special fittings according to AWWA C600.

e. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.

f. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.

8. If required to provide protection for metal piping, install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:

a. Hub-and-spigot, cast-iron soil pipe.

b. Hubless cast-iron soil pipe and fittings.

c. Ductile-iron pipe and fittings.

d. Expansion joints and deflection fittings.

9. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

C. Pipe Joint Construction

1. Join gravity-flow, nonpressure, drainage piping according to the following:

a. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

b. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

c. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

d. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.

e. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.

f. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.

g. Join PVC corrugated sewer piping according to ASTM D 2321.

h. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.

i. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

j. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

k. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.

l. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.

m. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.

n. Join dissimilar pipe materials with nonpressure-type, flexible **OR** rigid, **as directed**, couplings.

2. Join force-main, pressure piping according to the following:

   a. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.

   b. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.

   c. Join PVC pressure piping according to AWWA M23 for gasketed joints.

   d. Join PVC water-service piping according to ASTM D 2855.

   e. Join dissimilar pipe materials with pressure-type couplings.

3. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

   a. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

      1) Unshielded **OR** Shielded, **as directed**, flexible **OR** rigid, **as directed**, couplings for pipes of same or slightly different OD.

2) Unshielded, increaser/reducer-pattern, flexible **OR** rigid, **as directed**, couplings for pipes with different OD.

3) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

b. Use pressure pipe couplings for force-main joints.

D. Manhole Installation

1. General: Install manholes complete with appurtenances and accessories indicated.

2. Install precast concrete manhole sections with sealants according to ASTM C 891.

3. Install FRP manholes according to manufacturer's written instructions.

4. Form continuous concrete channels and benches between inlets and outlet.

5. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

6. Install manhole-cover inserts in frame and immediately below cover.

E. Concrete Placement

1. Place cast-in-place concrete according to ACI 318.

F. Backwater Valve Installation

1. Install horizontal-type backwater valves in piping manholes or pits.

2. Install combination horizontal and manual gate valves in piping and in manholes.

3. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

G. Cleanout Installation

1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

a. Use Light-Duty, top-loading classification cleanouts in earth **OR** unpaved foot-traffic, **as directed**, areas.

b. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.

c. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

d. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

2. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade.

3. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

H. Connections

1. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste And Vent Piping".

2. Connect force-main piping to building's sanitary force mains specified in Division 22 Section "Sanitary Waste And Vent Piping". Terminate piping where indicated.

3. Make connections to existing piping and underground manholes.

    a. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

    b. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

    c. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

        1) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.

        2) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

    d. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

4. Connect to grease **OR** oil **OR** sand, **as directed**, interceptors specified in Division 22 Section "Sanitary Waste Interceptors".

I. Closing Abandoned Sanitary Sewer Systems

1. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

    a. Close open ends of piping with at least 8-inch- (203-mm-) thick, brick masonry bulkheads.

    b. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

2. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

    a. Remove manhole and close open ends of remaining piping.

    b. Remove top of manhole down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

3. Backfill to grade according to Division 31 Section "Earth Moving".

J. Identification

1. Materials and their installation are specified in Division 31 Section "Earth Moving". Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
    a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
    b. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

K. Field Quality Control

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
    a. Submit separate report for each system inspection.
    b. Defects requiring correction include the following:
        1) Alignment: Less than full diameter of inside of pipe is visible between structures.
        2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
        3) Damage: Crushed, broken, cracked, or otherwise damaged piping.
        4) Infiltration: Water leakage into piping.
        5) Exfiltration: Water leakage from or around piping.
    c. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
    d. Reinspect and repeat procedure until results are satisfactory.
2. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
    a. Do not enclose, cover, or put into service before inspection and approval.
    b. Test completed piping systems according to requirements of authorities having jurisdiction.
    c. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
    d. Submit separate report for each test.
    e. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
        1) Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
        2) Close openings in system and fill with water.
        3) Purge air and refill with water.
        4) Disconnect water supply.
        5) Test and inspect joints for leaks.

OR

Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

6) Option: Test plastic gravity sewer piping according to ASTM F 1417.

7) Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).

f. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1035 kPa).

1) Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.

2) PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.

g. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).

3. Leaks and loss in test pressure constitute defects that must be repaired.

4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

L. Cleaning

1. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 22 05 76 00

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SECTION 22 10 23 00 - PLUMBING PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Refer also to the General Requirements Division 01 Specification Sections included in this contract.

B. Refer also to all other Division 22 Specification Sections included in this contract.

1.02 SUMMARY

A. Furnish and install pumps and associated controls as indicated herein. This includes all required wiring between various components in the system, hardware and associated items for a complete operational system.

1.03 REFERENCE STANDARDS

A. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

B. All materials, installation and workmanship shall comply with the latest revision of the following codes and standards:

1. Underwriters Laboratories
2. Uniform Plumbing Code
3. National Electric Code
4. National Electrical Manufacturers Association
5. ANSI/NSF Standard 61 - Drinking Water System Components - Health Effects
6. ASME American Society of Mechanical Engineers – Pressure vessels and hydro-pneumatic expansion tanks, piping and pumps.
7. (ASME - ANSI) A17.1 Safety Code for Elevators.
8. Texas Administrative Code, Title 16, Part 4, Chapter 74 Elevators and Related Equipment.
9. NSF National Sanitation Foundation.
10. (UL) Underwriters Laboratories.
11. (TCEQ) Texas Commission on Environmental Quality, Wastewater discharge rules and regulations.
12. University of Texas (EHS) Environmental Health and Safety.
13. Federal Regulations 29 CFR 1910.399 and certified through ETL under Category 225 and ULQCZJ.

1.04 QUALITY ASSURANCE

A. The equipment for each pumping system specified under this section shall be furnished by a single supplier and shall be products that the manufacturer regularly engages in. The supplier shall have sole responsibility for proper functioning of the system and equipment supplied.

B. The manufacturer of the pumping systems shall be responsible for compliance with all applicable codes and regulations, and be held accountable for the complete pump packages, and installation as specified herein.

C. Manufacturer's Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience. The packaged system manufacturer shall have 24 hour local service available provided by a trained factory authorized representative.

D. Conductors shall be numbered and identified at all termination points. All wiring shall be installed in wire ways and secured with tie straps. All disconnects, transformers, controllers, control devices, selector switches, and indicator lights package shall be labelled with their respective function and/or identification. Permanently affix a factory wiring schematic to the inside of cabinet door. The entire control panel shall bear the UL Label for enclosed industrial control panels.

E. Installer's Qualifications: The system shall be installed by a firm having minimum three years of experience regularly engaged in the installation of pumping packages similar to the ones specified herein.

F. Certification shall obtained by the manufacturer indicating that the function and performance characteristics of all products and materials have been determined by testing and ongoing surveillance by an approved third-party certification agency. Assertion of certification shall be in the form of identification in accordance with the requirements of the third-party certification agency.

G. Ensure pumps operate at specified system fluid temperatures without cavitation or vapor binding. Pumps shall be non-overloading in parallel or individual operation. Pumps shall operate within 10 percent of midpoint of published maximum efficiency curve.

PART 2 - PRODUCTS

2.01 DOMESTIC HOT WATER CIRCULATION PUMPS

A. Provide maintenance free circulation pumps designed for 125 psig working pressure at 225 degrees F continuous water temperature and specifically designed for quiet operation. These pumps shall be Bell and Gossett, Taco, or Grundfos having a circulating capacity as shown on the Drawings. Pumps shall have stainless steel fitted construction with iron body with steel ground and polished shaft with metal impregnated carbon thrust bearing. Motor shall be non-overloading at any point on the pump curve, open drip proof, sleeve bearings, quiet operation, rubber mounted construction, with built-in thermal overload protection. Coupling shall be flexible self-aligning. Furnish for the control of each pump an Allen Bradley Bulletin 600 Toggle Switch or equal, with thermal overload protection and pilot light.

B. Include the pump option for remote start/stop and status so that future connection to the building BAS is possible, if needed.

2.02 DOMESTIC WATER PUMPING SYSTEM:

A. The domestic water pumping system shall consist of N+1 centrifugal, automatic, variable speed pumps operated from one local control panel or the BAS. The pumping package shall conform to NSF61. The pump system shall be factory assembled on a steel skid including pumps, motors, valves, Type "L" copper or Schedule 40 300 series stainless steel suction and discharge manifolds, all interconnecting piping, wiring, variable frequency drives with logic and power controls.

B. Motor shall be NEMA close-coupled type with a JM shaft. Motors shall be high efficiency, open drip proof, and manufactured in accordance with NEMA standards. Each motor shall be equipped with the manufacturer's nameplate and shall have a sufficient horsepower rating to operate the pump at any point on the pump's head-capacity curve without overloading the nameplate horsepower rating of the motor, regardless of service factor. The motor shall have a service factor of 1.15 for variations in voltage and frequency.

C. The controller panel shall be floor mounted, of NEMA 1 design, with all input/output power and signal wiring brought to a factory pre-wired control strip(s). All components shall come completely factory assembled and wired. The package shall be designed to allow for removal and/or repair of one pump without the entire pumping system being taken down.

D. The pump control panel shall contain HOA switches, alarm lights, run lights, fused disconnect switches, starters, limit switches for high supply pressure cut-off and low suction pressure cut-off, and devices as needed for variable speed control, lag pump delay start, and lag/lead pump swap. At minimum, provide auxiliary contacts for pump status and a general alarm for connection to the building BAS.

E. If the pump controls will be done by the building BAS, then provide suction pressure and supply pressure sensors and the following VFD control points: Start/Stop, Speed Command, Speed Feedback, Fault, and KW.

F. The pump package provider shall provide a sequence of operation which describes how the pump speed varies and how lead and lag pumps should operate together.

G. Provide isolation valves on each pump suction and discharge and a non-slam check valve on each pump discharge. Package water piping shall be stainless steel. All valves shall be threaded full port ball type valves for pipe sizes 2” and smaller or flanged butterfly type valves for pipe sizes over 2”. Locate a pressure gauge at the equipment skid inlet and discharge headers. All fittings shall be flanged or threaded and completely lead free.

H. The package shall be designed to allow removal and/or repair to one pump without the entire pumping system being taken down.

I. For pump motor VFD selection, refer to Specification Section 23 29 00 Variable Frequency Drives.

J. Only if needed, provide a correctly sized ASME coded pre-charged hydro-pneumatic expansion tank constructed with a minimum working pressure of 150 psig. Internal wetted parts shall be compliant with the codes and standards above.

K. Provide pumping system as manufactured by Grundfos, Armstrong, Bell & Gossett, Canariis, or Syncroflo.

2.03 ELEVATOR SUMP PUMPS

A. Provide complete and operational elevator sump pumps as specified herein, as scheduled, as shown on the Drawings, and in accordance with the elevator code listed above.

B. Pumps: The elevator sump pump shall be completely submersible cast iron shell with bronze impeller, stainless steel shaft, motor shall be hermetically sealed, capacitor start with built-in overload protection, bearings shall be factory sealed grease lubricated ball type and with float operated mercury switch. Provide minimum 20’ of power cord. Pump capacities shall be as scheduled on the Drawings.

C. Control Panel shall be NEMA 4X, 120 volt, complete with alarm sound and lights, silence switch, mounting hardware, and all necessary devices to control the pump to automatically operate per the pump manufacturer's instructions. Mount the panel in the elevator pit accessible from the elevator doors. Provide dry contacts for the building BAS to indicate pump status (each pump), high liquid alarm, and flood alarm.

D. Wiring between control panel and pumps shall be the responsibility of this Contractor and coordinated with Division 26.

E. Coordinate all sump pump components with elevator cab clearance. Meet all local and state code requirements.

F. Refer to UT EHS Guidelines for elevator sump pump installation and operation requirements.

2.04 SUMP PUMPS and SEWAGE EJECTORS:

A. General: Provide and install duplex pumping system package with prewired alternator and adjustable level controls, consisting of mercury float level switches. Float switches shall be secured to pump discharge riser pipe with adjustable stainless steel bands. Float switches shall control lead pump on, lag pump on, pump off and high water alarm. System shall be complete with control panel. Refer to floor plans for location of control panel. A local disconnect switch shall be provided by Division 26. Wiring between control panel, system pumps and float switches shall be the responsibility of this contractor. Final electrical connections to control panel and float switches, as well as system testing shall be the responsibility of this contractor. Electrical work shall comply with Division 26 specification requirements.

B. Pump: The sump pump shall be completely submersible non-clog, cast iron housing with bronze impeller, stainless steel shaft, ceramic mechanical seal with hermetically sealed motor with overload protection, factory sealed grease lubricated ball bearings. Motors shall be hermetically sealed, capacitor start, with built-in overload protection. Provide minimum of 20’ of power cable for power connection. Level switches shall be secured to discharge with manufacture supplied stainless steel float clamps.

C. Pump Removal Rail System (where indicated on drawings): Provide pump removal rail system consisting of guide rails, hydraulic sealing flange for pumps, carrier guide bracket, discharge base elbow with base plate and type 316 stainless steel pump lifting chain. The rail shall be of corrosion resistant construction, which will allow for alignment of pumps upon removal. A hydraulic sealing flange shall be provided for each pump discharge, in order to lock pump discharge into place, upon the pumps being re-inserted into basin.

D. Control Panel shall be NEMA 3R steel enclosure with padlock provisions, hinged door, circuit breakers (compliant with NEC 430.52), HOA switches, run lights, duplex controller with pump alternator, float operation indicator lights, motor starters, step down transformer, and capable of being mounted away from the sump and pumps. Provide dry contacts for the building BAS to indicate pump status (each pump), high liquid alarm, and flood alarm.

E. Wiring and conduit between control panel and disconnect switch in crawl space and pumps shall be the responsibility of this Contractor and coordinated with Division 26.

F. Sump Tank: Furnish cast iron, steel or polyethylene sump basin with gas tight cover. Sump cover shall have manhole with bolted cover, vent connection, openings for pumps and controls. Sump shall be sized to allow an adequate volume of water to accumulate for a minimum one minute cycle of pump operation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, and state requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Furnish all supports required by the equipment included in this Contract.

D. Provide a 4" thick, reinforced concrete housekeeping pad beneath pump skids, except for sump pumps.

E. Furnish and install all necessary valves, traps, gauges, strainers, unions, etc. to facilitate proper functioning and servicing of equipment.

F. Provide dielectric isolation device where copper lines connect to ferrous lines or equipment, such as dielectric coupling or dielectric flange fitting.

G. Pipe relief valves discharge and all equipment drains indirectly to appropriate floor drain.

H. Set the equipment operating and safety controls.

I. Coordinate equipment electrical connections with Division 26 requirements. Ground equipment and connect wiring according to Division 26 specified requirements.

3.02 STARTUP

A. Startup shall be performed by factory trained and an authorized person. The factory representative shall also provide technical and practical operation and maintenance training to include in the field operation and maintenance instructions, handouts, visual aids, and specialty tools (if needed).

END OF SECTION 22 10 23

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SECTION 22 11 16 00 - PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Provide materials and installation for complete first class plumbing systems, within and to five feet beyond building perimeter unless noted otherwise on Contract Drawings; Sanitary Waste and Vent Piping, Storm Drain Piping, Domestic Water Piping, Domestic Water Valves, Testing and other normal parts that make the systems operable, code compliant and acceptable to the authorities having jurisdiction.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. 2015 Edition of the International Plumbing Code.
2. ANSI/NSF Standard 61 - Drinking Water System Components - Health Effects.

1.04 QUALITY ASSURANCE

A. Manufacturer’s name and pressure rating shall be permanently marked on valve body.

B. The Contractor shall notify the manufacturer's representative prior to installing any copper press fittings. The Contractor shall obtain the representative’s guidance in any unfamiliar installation procedures. The manufacturer's representative of copper press fittings shall conduct periodic inspections of the installation and shall report in writing to the Contractor and Owner of any observed deviations from manufacturer’s recommended installation practices.

C. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section. All pipe, fittings, couplings, gaskets and valves shall be manufactured domestically.

D. Installer Qualifications:

1. Company shall have minimum three years documented experience specializing in performing the work of this section.
2. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

3. All installers of copper press fittings shall be trained by the fitting manufacturer's appointed representative. Written notification of training shall be submitted to Owner prior to any installation.

1.05 SUBMITTALS

A. Product Data:

1. Code and Standards compliance, manufacturer's data for pipe, fittings, valves and all other products included within this specification section.

2. Manufacturer’s installation instructions.

B. Record Documents:

1. Record actual locations of valves, etc. and prepare valve charts.

2. Test reports and inspection certification for all systems listed herein.

3. Provide a certificate of completion detailing the domestic water system chlorination procedure and all laboratory test results.

4. Submit proposed location of access panels which vary from quantities or locations indicated on Contract Drawings.

5. Provide full written description of manufacturer’s warranty.

C. Operation and Maintenance Data:

1. Include components of system, servicing requirements, Record Drawings, inspection data, installation instructions, exploded assembly views, replacement part numbers and availability, location and contact numbers of service depot.

1.06 DELIVERY, STORAGE AND HANDLING

A. All materials shall be new, undamaged, and free of rust.

B. Accept valves on Site in shipping containers and maintain in place until installation.

C. Provide temporary protective coating and end plugs on valves not packaged within containers. Maintain in place until installation.

D. Provide temporary end caps and closures on pipe and fittings. Maintain in place until installation.

E. Protect installed piping, valves and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc. Remove dirt and debris and repair materials as work progresses and isolate parts of completed system from uncompleted parts.

F. Protect all materials that are to be installed within this project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.

1.07 EXTRA MATERIALS

A. Provide The University with one differential pressure meter kit for use with domestic hot water return circuit balancing valves installed within this project. Kit shall include meter, hoses, connection accessories, circular slide rule, carrying case and valve manufacturer’s curve charts.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide materials as specified herein and indicated on Contract Drawings. All materials and work shall meet or exceed all applicable Federal and State requirements and conform to adopted codes and ordinances of authorities having jurisdiction.

C. Pressure ratings of pipe, fittings, couplings, valves, and all other appurtenances shall be suitable for the anticipated system pressures in which they are installed.

2.02 SANITARY WASTE AND VENT AND STORM DRAINAGE PIPING (AS INDICTED ON DRAWINGS)

A. Service weight cast iron soil pipe and fittings with hubless connections using clamp type gasketed mechanical fasteners above ground and hub and spigot DWV pipe and fittings with neoprene compression gasket joints for all buried pipe. Cast iron soil pipe, fittings and hub gaskets shall be manufactured by Tyler Pipe or Charlotte Pipe and Foundry. All cast iron pipe and fittings shall be of the same manufacturer.

B. Unburied storm drainage and sanitary waste and vent piping for sizes 4” and smaller may be seamless copper DWV tube with wrought copper or wrought copper alloy solder joint drainage pattern DWV fittings.

C. Indirect waste piping sizes 1-1/4” through 2” serving fixtures and equipment shall be seamless copper DWV tube with wrought copper or wrought copper alloy solder joint drainage pattern DWV fittings.

D. Indirect waste piping sizes 1” and smaller serving equipment shall be type "L" hard drawn copper pipe and wrought copper or cast copper alloy solder joint fittings using lead-free solder and non-corrosive flux. Elbows shall be long radius type. Tee fittings shall be combination wye with 45 degree elbow.

E. Cast iron soil pipe compression gaskets shall be monolithically molded from an elastomer meeting ASTM C 564 and shall be of same manufacturer as pipe and fittings.

F. Clamps for joining hubless cast iron pipe and fittings sizes 10” and smaller shall meet the performance criteria of FM 1680, have 28 gauge type 304 stainless steel jacket, minimum .094 inch thick ASTM C 564 neoprene gasket and type 305 stainless steel band screws designed to be installed with a pre-set torque wrench calibrated at 80 inch pounds. Couplings shall be manufactured by Clamp-All, Inc. HI-TORQ 80 or Husky, Inc., Orangeshield HD 4000.

G. Clamps for joining hubless cast iron pipe and fittings sizes 12” and 15” shall meet the performance criteria of FM 1680, have 24 gauge type 304 stainless steel jacket, minimum .100 inch thick ASTM C 564 neoprene gasket and type 305 stainless steel band screws designed to be installed with a pre-set torque wrench calibrated at 125 inch pounds. Couplings shall be manufactured by Clamp-All, Inc. HI-TORQ 125.

H. Hubless piping systems shall not be used in a directly buried, underground application. EXCEPTION: No-hub type fittings with clamp type coupling joints may be used below ground for pipe sizes up to 10” at connections to existing cast iron sewers provided couplings are cast iron with stainless steel bolts as manufactured by MG Piping Products.

I. Solder for copper piping shall be lead-free Tin/Copper/Silver/Nickle(optional) solder conforming to ASTM B32, Wolverine Silvabrite 100 Lead-Free Solder or Harris Nick Lead-Free Solder. Use water soluble flux recommended by solder manufacturer and conforming to ASTM B813 and NSF 61, Wolverine Silvabrite 100 Water Soluble Flux or Bridgit Water Soluble Paste Flux.

J. Lubricant for drainage cleanout plugs shall be Loctite Marine Grade Anti-Seize or approved.

K. Double sanitary tee fittings shall be not be used as a drainage fitting.

L. Provide IAPMO figure one, IAPMO figure five or double wye and eighth bend fittings on vertical lines serving back-to-back fixture drains.

M. Double wye and eighth bend fittings shall not be installed in horizontal drain lines.

N. All P-traps for floor drains, floor sinks and hub drains shall be deep-seal type.

O. Provide threaded brass or copper adapters to connect fixture supply stops and waste to service piping within walls. Galvanized nipples shall not be acceptable. Provide DWV copper trap adapters to connect lavatory, sink and drinking fountain trap outlets to sanitary system.

2.03 DOMESTIC WATER PIPING (INCLUDING COLD, HOT & SOFTENED WATER)

A. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61.

B. All brass and bronze piping materials within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content.

C. Unburied piping shall be type "L" hard drawn copper pipe and wrought copper or cast copper alloy solder joint fittings using lead-free solder and non-corrosive flux. Piping sizes 2-1/2” and larger may be type “L” hard drawn copper and wrought copper or cast copper alloy roll groove fittings utilizing no-sweat coupling and flange adapter assemblies as manufactured by Victaulic or Anvil.

D. Unburied piping sizes ½” through 2" installed within occupied buildings for modifying systems having an operating pressure that will not exceed 200 p.s.i.g. may utilize copper press fittings manufactured by NIBCO conforming to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM. Copper press fittings shall be rated at 200 psi working pressure and 250 degree working temperature. All copper press fittings, couplings and specialties shall be the products of a single manufacturer. Installation tools shall be of the same manufacturer as the components.

E. Solder for copper piping shall be lead-free Tin/Copper/Silver/Nickle(optional) solder conforming to ASTM B32, Wolverine Silvabrite 100 Lead-Free Solder or Harris Nick Lead-Free Solder. Use water soluble flux recommended by solder manufacturer and conforming to ASTM B813 and NSF 61, Wolverine Silvabrite 100 Water Soluble Flux or Bridgit Water Soluble Paste Flux.

F. Buried domestic water service entrance piping 4” and larger shall be cement mortar lined Class 53 ductile iron pipe and 350 psi working pressure ductile iron fittings using mechanical joints. All buried ductile iron pipe and fittings shall be encased in polyethylene per ANSI/AWWA Standard C105/A21.5, Method A. Minimum thickness of polyethylene shall be 8 mil.

G. Buried pressurized piping sizes 1” and smaller shall be type “K” soft copper. No joints shall be allowed below slab. Encase piping within ½” thick un-slit flexible tube type elastomeric thermal insulation up to 1” above slab at both ends. Insulation shall be AP/Armaflex or Rubatex Insul-Tube 180.

H. Unburied trap primer piping shall be same as specified for domestic water except all elbows shall be long radius type.

I. Buried trap primer piping shall be type “K” soft copper. No joints shall be allowed below slab except at connection to drain. Encase piping within ½” thick un-slit flexible tube type elastomeric thermal insulation up 1” above slab. Insulation shall be AP/Armaflex or Rubatex Insul-Tube 180.

J. Dielectric waterway fittings shall have zinc electroplated steel pipe body with high temperature stabilized polyolefin polymer liner; manufactured by Victaulic, Style 47 or PPP, Inc. Series 19000.

K. Dielectric unions shall be rated at 250 psi, ground-joint type with inert, non-corrosive thermoplastic sleeve. End connection materials shall be compatible with respective piping materials; manufactured by EPCO Sales, Inc. Provide models to suit applicable transitions.

L. Dielectric flanges shall be rated at 175 psi, have nylon bolt isolators and dielectric gasket. Materials shall be compatible with respective piping materials; manufactured by EPCO Sales, Inc. Provide models to suit applicable transitions.

M. Pipe joint compound shall be lead-free, non-toxic, non-hardening and compliant with ANSI/NSF 61 and Federal Specification TT-S-1732. Temperature service range of -15ºF to +400ºF, manufactured by approved equal by Rectorseal or Oatey.

2.04 DOMESTIC WATER VALVES: (INCLUDING COLD, HOT & SOFTENED WATER)

A. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61.

B. All brass and bronze valve materials within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content.

C. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacturer, etc. EXCEPTION: 2-1/2” & 3” ball valves may be by a different manufacturer than 2” and smaller ball valves.

D. Line Shut-Off Valves up to and including 2” shall be two-piece bronze body of ASTM B584 Alloy 844, ASTM B61, or ASTM B62, full port ball type rated at 600 WOG with threaded connections, blow-out proof stem, plastic coated handle, Teflon packing, 316 stainless steel ball and stem. Acceptable valves are NIBCO Model T-585-70-66, or approved equivalent model by Apollo.

E. Line Shut-Off Valves sizes 2-1/2” and 3” shall be full port ball type rated at 400 WOG with threaded connections, two-piece bronze body ASTM B584 with 316 stainless steel ball and stem, plastic coated handle, blow out proof stem and reinforced Teflon seats. Acceptable valves approved equivalent model by NIBCO or Apollo.

F. Line Shut-Off Valves 4” and larger where system operating pressure will not exceed 160 p.s.i.g. shall be 200 WOG threaded lug type ductile iron body butterfly valve with extended neck, lever handle, 416 stainless steel stem, aluminum bronze disc, EPDM liner and seal, suitable for bi-directional flow and dead end service with downstream flange removed. Acceptable valves are NIBCO Model LD-2000, or approved equivalent model by Apollo.

G. Line Shut-Off Valves 4” and larger installed within systems having design operating pressures between 160 and 250 p.s.i.g. shall be threaded lug type ductile iron body butterfly valve with extended neck, lever handle, 316 stainless steel stem and disc, EPDM liner and seal, suitable for bi-directional flow and dead end service with downstream flange removed. Acceptable valves are NIBCO Model LD-3022, or approved equivalent model by Apollo.

H. Line Shut-Off Valves 4” and larger installed in roll grooved copper systems may be 300 psi roll grooved end type bronze body butterfly valve with lever handle, bronze trim, EPDM coated disc, suitable for bi-directional flow and dead end service. Manufactured by Victaulic Model V-*size*-3-6-2-2-11.

I. Provide stem extensions of a non-thermal conducting material for valves in insulated lines to allow unobstructed operation.

J. Provide memory stops on all ball valves installed in domestic hot water return lines. Memory stops shall be adjustable after pipe insulation is applied.

K. Provide line shut-off valves that have the same inside diameter of the upstream pipe in which they are installed.

L. Domestic Hot Water Return Circuit Balancing Valves 1/2" through 2" shall be ‘Y or T’ pattern with threaded inlet and outlet connections, equal percentage globe-style and provide precise flow measurement, precision flow balancing and positive drip-tight shut-off. Valves shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360° handwheel turns. 90° ‘circuit-setter’ style ball valves are not acceptable. Valve handle shall have hidden memory feature to provide a means for locking the valve position after the system is balanced. Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, 1/4" threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The handwheel shall be high-strength resin. Provide valves as scheduled on Contract Drawings manufactured by Armstrong Model CBV-VT or NIBCO T-1710 and F737-A. Furnish each valve complete with optional pre-formed 25/50 fire/smoke rated insulation.

M. Swing Check Valves, 2" and smaller - “Y” or “T” pattern bronze, Class 150, with threaded connections and screw-in cap. Manufactured by NIBCO Model T-433-Y or approved equivalent model by Apollo.

N. Spring Loaded Check Valves, 2" and smaller - Silent closing, bronze, Class 125, with threaded connections, Buna disc, bronze or stainless steel spring. Manufactured by NIBCO Model T-480 or approved equivalent model by Apollo.

O. Swing Check Valves, 2-1/2" and larger - 200 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-918-B or approved equivalent model by Apollo.

P. Swing Check Valves, 2-1/2" and larger - 285 pound CWP, Iron body, with stainless steel trim. Manufactured by NIBCO Model F-938-33 or approved equivalent model by Apollo.

Q. Spring Loaded Check Valves, 2-1/2" and larger - 200 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-910 or approved equivalent model by Apollo.

R. Spring Loaded Check Valves, 2-1/2" and larger - 400 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-960 or approved equivalent model by Apollo.

2.05 DIFFERENTIAL PRESSURE METER: (FOR DOMESTIC HOT WATER CIRCUIT BALANCING VALVES)

A. Meter shall be equipped with one 4-1/2” round dial gauge, 0-135” pressure differential, one 4-1/2” round dial gauge, 0-60’ pressure differential, 300 psig maximum working pressure, two five foot hoses with PMP connections and carrying case. Meter and accessories shall be manufactured by Armstrong Model CBDM-135/60 or NIBCO 1022.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry and not over-excavated. Do not install underground piping when bedding is wet or frozen.

B. Before commencing work, check final grade and pipe invert elevations required for drain terminations and connections to ensure proper slope.

3.02 PREPARATION

A. Ream pipes and tubes. Remove burrs, scale and dirt, inside and outside, before assembly. Remove foreign material from piping.

B. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. General

1. Care shall be exercised to avoid all cross connections and to construct the plumbing systems in a manner which eliminates the possibility of water contamination.

2. Install all materials and products in accordance with manufacturer's published recommendations. Use tools manufactured for the installation of the specific material or product.

3. Heat generated by soldering procedures shall not be transmitted to valves, copper alloy roll groove fittings, copper press fittings, no-hub clamps, or any other components installed within the piping system that may be damaged due to high temperatures. Contractor shall take all precautions necessary, including utilizing wet wrapping or allowing heated piping to cool to ambient temperature before attachment.

4. Pipe joints, no-hub clamps, flanges, unions, etc., shall not directly contact or be encased in concrete, or be located within wall, floor or roof penetrations.

5. Route piping in direct orderly manner and maintain proper grades. Installation shall conserve headroom and interfere as little as possible with use of spaces. Route exposed piping parallel to walls. Group piping whenever practical at common elevations.

6. Install piping to allow for expansion and Contraction without stressing pipe, joints or connected equipment.

7. Furnish all supports required by the piping included in this specification section.

8. Penetrations through fire rated walls, floors and partitions shall be sealed to provide a U.L. rating equal to or greater than the wall, floor or partition.

9. Seal all penetrations through floors, exterior building walls and grade beams air and water tight.

10. Each plumbing pipe projecting through roof shall be installed in accordance with Contract Specifications and Drawings. Penetrations shall be sealed air and water tight. Refer to details on Contract Drawings and coordinate with General Contractor for flashing requirements.

11. Furnish and install all necessary valves, traps, gauges, strainers, unions, etc. for each piece of equipment (including Owner furnished equipment) having plumbing connections, to facilitate proper functioning, servicing and compliance with code.

12. Provide code-approved transition adapters when joining dissimilar piping materials. Adaptors installed shall be manufactured specifically for the particular transition.

13. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.

14. Bury outside water and drainage pipe minimum one foot below recorded frost depth.

15. Buried piping shall be supported throughout its entire length.

16. All excavation required for plumbing work is the responsibility of the plumbing Contractor and shall be done in accordance with Contract Documents.

17. Piping shall be insulated in accordance with Contract Documents.

18. Provide clearance for installation of insulation and for access to valves, air vents, drains, unions, etc.

19. Provide dielectric isolation device where non-ferrous components connect to ferrous components. Devices shall be dielectric union, coupling or dielectric flange fitting.

20. All piping shall be isolated from building structures, including partition studs, to prevent transmission of vibration and noise.

21. Isolate all bare copper pipe from ferrous building materials. Yellow Insulation Tape is acceptable.

22. All nipples or associated piping to the first cut-off valve, connected to pipe taps for domestic, heating, hot water, chilled water, steam, condensate, chemical injection, chemical recirculation, etc., will be stainless steel. First cut-off valve on tap shall be stainless steel or brass.

D. Drainage and Vent Systems

1. Slope drainage lines uniformly at 1/4" per foot, for lines 3" and less, and 1/8" per foot for larger lines, unless noted otherwise on Contract Drawings. Maintain gradients through each joint of pipe and throughout system.

2. Buried pipe shall be laid on a smoothly graded, prepared subgrade soil foundation true to alignment and uniformly graded. Bell holes shall be hand-excavated so that the bottom of the pipe is in continuous contact with the surface of the prepared subgrade material. Piping invert shall form a true and straight line.

3. The size of drainage piping shall not be reduced in size in the direction of flow. Drainage and vent piping shall conform to the sizes indicated on the Contract Drawings. Waste lines from water closets shall not be smaller than four inches. Under no circumstances shall any drain or vent line below slab be smaller than two inches.

4. Unburied horizontal cast iron soil piping shall be supported at least at every other joint except that when the developed length between supports exceeds four feet, they shall be provided at each joint. Supports shall also be provided at each horizontal branch connection and at the base of each vertical rise. Supports shall be placed immediately adjacent to the joint. Suspended lines shall be braced to prevent horizontal movement. Unburied vertical cast iron soil piping rising through more than one floor level shall be supported with riser clamps at each floor level.

5. Install couplings for hubless pipe and fittings in accordance with manufacturer's published recommendations. Use pre-set torque wrench and tighten band screws to 80 inch pounds minimum or as required by manufacturer’s published instructions.

6. All unburied change of direction fittings within the roof drainage system shall be braced against thrust loads that might result in joint separation due to dynamic forces caused by sudden, heavy rainfall conditions. Bracing shall incorporate galvanized steel pipe clamps and tie rods.

7. Provide cleanouts within sanitary waste systems at locations and with clearances as required by the code, at the base of each waste stack and at intervals not exceeding 90 feet in horizontal runs.

8. Provide cleanouts at the base of each vertical downspout and at intervals not exceeding 90 feet in horizontal building storm drain. Provide clearances as required by code. Horizontal roof drain piping located above building ground floor level will not require cleanouts.

9. A removable sink or lavatory p-trap with cleanout plug shall be considered as an approved cleanout for 2” diameter pipe.

10. All interior cleanouts shall be accessible from walls or floors. Provide wall cleanouts in lieu of floor cleanouts wherever possible. A floor cleanout shall be installed only where installation of a wall cleanout is not practical.

11. Provide a wall cleanout for each water closet or battery of water closets. Locate wall cleanouts above the flood level rim of the highest water closet but no more than twenty four inches above the finished floor.

12. Coordinate the location of all cleanouts with the architectural features of the building and obtain approval of locations from the Project Architect.

13. Lubricate cleanout plugs with anti-seize lubricant before installation. Prior to final completion, remove cleanout plugs, re-lubricate and reinstall using only enough force to provide a water and gas tight seal.

14. Install trap primer supply to floor drains, hub drains and floor sinks that are susceptible to trap seal evaporation and where indicated on Project Drawings. Primer unit installation shall comply with manufacturer's published recommendations. Trap primer lines shall slope to drain at a minimum ¼” per foot.

15. Capped waste and vent connections for future extensions shall be located accessibly and not extend more than 24” from active main. Waste connections and vent connections shall be located at elevations that will allow future installation of properly sloped piping without the need to dismantle or relocate installed ductwork, piping, conduit, light fixtures, etc.

16. Unless indicated otherwise within Contract Documents, all sanitary vent pipes passing through the roof shall be provided with lead roof flashings constructed of 2-1/2 pound sheet lead with bases extending no less than ten inches on each side of the pipe. The vertical portion of the flashing shall extend upward the entire length of pipe and be turned tightly inside the pipe at least two inches and shall not reduce the inside diameter of vent pipe more than the thickness of the flashing. Lead flashings shall be furnished by Plumbing Contractor and turned over to Roofing Contractor for installation.

17. Locate all sanitary vent terminals a minimum of 10 feet horizontally from or 5 feet vertically above all air intakes, operable windows, doors and any other building openings.

18. Wastewater when discharged into the building drainage system shall be at a temperature not higher than 140°F. When higher temperatures exist, approved cooling methods shall be provided.

E. Domestic Water System

1. On each water supply line serving a plumbing fixture, item of equipment, or other device which has a water supply discharge outlet below the overflow rim, or where cross contamination may occur, provide and install an approved vacuum breaker or backflow preventer. Installation of vacuum breakers shall prevent any possible backflow through them.

2. Provide thrust blocking and clamps for mechanical joint or gasketed underground water pipe at fittings with 3/4" rods, and properly anchor and support. Restraining rods, clamps and hardware shall be thoroughly coated with bituminous material to prevent corrosion.

3. Copper piping shall be supported at no greater than six foot intervals for piping 1-1/2" and smaller and ten foot intervals for piping 2" and larger in diameter.

4. Install all water piping to allow all piping within the system to be drained at low points.

5. Air chambers, dead-legs, or any other piping arrangement that may allow water to stagnate shall not be installed within domestic water systems. Valves installed for future connections shall not extend more than 24” from an active main.

6. Provide manufactured water hammer arrestors in water supply lines as indicated on Contract Drawings and in accordance with Standard PDI-WH201.

7. Pipe insulation shall be applied over installed freeze protection heat tracing tape.

8. Install union type fitting downstream of isolation valves at equipment connections.

9. Solder joint fittings shall not be installed within 24" of a copper press fitting.

10. Threaded adaptors shall be of the same manufacture and type as the system’s copper fittings.

11. Threaded adaptors on supply stub-outs shall be installed prior to construction of wall and shall not extend more than 1” beyond wall face.

12. Identify piping utilizing copper press fittings in accordance with project specification section 20 05 53.

F. Domestic Water Valves

1. Domestic water shut-off valves shall be installed where shown on Drawings, at each fixture and piece of equipment, at each branch take-off from mains, at the base of each riser, and at each battery of fixtures.

2. Install shut-off valves in accessible locations. Provide access panels where valves would otherwise be inaccessible. Coordinate quantity, size and location requirements of access panels with General Contractor.

3. Install shut-off valves with stems upright or horizontal, not inverted.

4. Where threaded valves are installed in copper piping systems special care shall be taken to avoid damaging the valve or its parts due to overheating. Install copper or bronze male adapters in each inlet of threaded valves. Sweat solder adapters to pipe prior to connecting to valve body.

5. Provide spring loaded type check valves on discharge of water pumps.

6. Provide accessible check valves in the individual cold and hot water fixture supply lines serving mixing valve type faucets or assemblies having hose connection outlets that are not equipped with integral check stops.

7. Install domestic hot water return circuit balancing valves where indicated on Contract Drawings and locate a minimum of five pipe diameters downstream and three pipe diameters upstream of all fittings and/or line shut-off valves. Location of valves shall allow unobstructed access for monitoring and adjustment.

8. Adjust and set domestic hot water return circuit balancing valves to flows indicated on Contract Drawings and in accordance with valve manufacturer’s published instructions. Use flow meter recommended by valve manufacturer.

9. Provide a temperature gauge, strainer, union and line shut-off valve upstream of each hot water return circuit balancing valve.

3.04 TESTING

A. General

1. Equipment, material, power, and labor necessary for the cleaning, flushing, sterilization, inspection and testing of systems covered within this Specification Section shall be furnished by the Plumbing Contractor. All testing and inspection procedures shall be in accordance with Division 1 and Special Condition requirements of this Contract.

2. All new and parts of existing altered, extended, or repaired plumbing system piping shall be tested and inspected for leaks and defects. Piping being tested shall not leak nor show any loss in test pressure for duration specified.

3. In cases of minor installation and repairs where specified water and/or air test procedures are deemed impractical, Contractor shall obtain written approval from Owner’s Representative to perform alternate testing and inspection procedures. Alternate testing and inspection procedures for minor installation and repairs shall include visual evaluation of installed components by Owner’s Representative during a simulation of use.

4. The water utilized for tests shall be obtained from a potable source of supply.

5. Prepare testing reports. If testing is performed in segments, submit separate report for each segment, complete with diagram or clear description of applicable portion of piping. After inspection has been approved or portions thereof, certify in writing the time, date, name and title of the persons reviewing the test. This shall also include the description of what portion of the system has been approved. Obtain approval signature by Owner’s Representative. A complete record shall be maintained of all testing that has been approved, and shall be made available at the job Site. Upon completion of the work, all records and certifications approving testing requirements shall be submitted to The University’s Representative before final payment is made.

6. Verify systems are complete, flushed and clean prior to testing. Isolate all equipment subject to damage from test pressure. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. Leave piping uninsulated, uncovered and unconcealed until it has been tested and approved. Where any portion of piping system must be concealed before completion of entire system, the portion shall be tested separately as specified for the entire system prior to concealment. Contractor shall expose all untested covered or concealed piping.

7. Gauges used for testing shall have increments as follows:

   a. Tests requiring a pressure of 10 psi or less shall utilize a testing gauge having increments of 0.10 psi or less.

   b. Tests requiring a pressure of greater than 10 psi but less than or equal to 100 psi shall utilize a testing gauge having increments of 1 psi or less.

   c. Tests requiring a pressure of greater than 100 psi shall utilize a testing gauge having increments of 2 psi or less.

8. Separately test above and below ground piping.

9. Do not introduce test water into piping systems when exposure to freezing temperatures is possible.

10. Do not introduce test water into sections of piping located above existing sensitive areas and/or equipment that may be damaged or contaminated by water leakage. Coordinate with Owner’s Representative to determine areas and/or equipment considered as being sensitive.

11. Defective work or material shall be reworked and replaced, and inspection and test repeated. Repairs shall be made with new materials. Pipe dope, caulking, tape, dresser couplings, etc., shall not be used to correct deficiencies.

12. The Contractor shall be responsible for cleaning up any leakage during flushing, testing, repairing and disinfecting to the original condition any building parts subjected to spills or leakage.

B. Drainage and Vent System

1. Subject gravity drainage and vent piping and joints to a vertical water column pressure of at least ten feet. If after 12 hours the level of the water has been lowered by leakage, the leaks must be found and stopped and the water level shall again be raised to the level described and the test repeated until, after a 12 hour retention period, there shall be no perceptible lowering of the water level in the system being tested. EXCEPTION: Portions of drainage and vent piping located on uppermost level of building shall be subjected to a water column pressure created by filling the system to point of overflow at roof vent terminals and roof drains. The pipes for the level being tested shall be filled with water to a verifiable and visible level as described above and be allowed to remain so for 12 hours.

2. Piping located above sensitive areas and/or equipment that may be damaged or become contaminated due to test water leakage shall be tested with air. Isolate the test section from all other sections and slowly fill pipe with oil-free air until there is a uniform gauge pressure of 5 pounds per square inch (34.5 kPa) or sufficient pressure to balance a 10-inch (254 mm) column of mercury. The air pressure shall be regulated to prevent the pressure inside the pipe from exceeding 5.0 PSIG. This pressure shall be held for a test period of at least 15 minutes. Any adjustments to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period.

3. Test forced (pumped) drainage piping by plugging the end of the piping at the point of connection with the gravity drainage system and applying a pressure of 5psi (34.5 kPa) greater than the pump rating, and maintaining such pressure for 15 minutes.

4. After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent and drain piping as required to isolate system being tested. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in fixture trap to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Should the completion of these tests leave any reasonable question of a doubt relative to the integrity of the installation, additional tests or measures shall be performed to demonstrate the reliability of these systems to the complete satisfaction of The University’s Representative.

6. Test plugs must extend outside the end of pipe to provide a visible indication for removal after the test has been completed.

C. Domestic Water System

1. Subject piping system to a hydrostatic pressure of at least 125 pounds per square inch gauge, but not less than the operating pressure under which it is to be used, for a period of no less than 12 hours. During test period, all pipe, fittings and accessories in the particular piping system that is being tested shall be carefully inspected. If leaks are detected, such leaks shall be stopped and the hydrostatic test shall again be applied. This procedure shall be repeated until no leaks are detected for an entire 12 hour period. EXCEPTION: Piping located above sensitive areas and/or equipment that may be damaged or become contaminated due to test water leakage shall be tested with oil-free air in lieu of water.

2. After completion of the testing, all new and/or altered water piping systems shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. Do not exceed 150 parts per million at any time. Introduce chlorine into the supply stream at a rate sufficient to provide a uniform concentration throughout the system. All outlets shall be opened and closed several times. When the specified level of chlorine is detected at every outlet in the system, close all valves to prevent release of water from the system for 24 hours. At the completion of the 24 hour disinfection period, test every outlet for a minimum chlorine residual of fifty parts per million. This minimum residual must be present to proceed with flushing. Flush the system with clean water at a sufficient velocity until the residual chlorine detected at every outlet is within 0.2 parts per million of the normal water supply’s level.

3. Sufficient samples must be taken no sooner than 24 hours after sterilization and flushing to represent the extent and complexity of the affected water system, along with a control sample to indicate municipal water quality at the time of testing. Send water samples to an accredited laboratory to perform qualitative and quantitative bacteriological analysis in accordance with AWWA C651. Contractor shall obtain written certification from the independent testing agency stating that the water samples meet Federal and State guidelines for safe drinking water. Upon satisfactory completion of all procedures, and receipt of acceptable laboratory test results, obtain written approval by Owner's representative. Failure to fully comply with the above procedures will result in a requirement to repeat the procedure until acceptable results are achieved, at no additional cost to The University.

4. Isolate or bypass equipment that would be detrimentally affected by disinfecting solution. Isolate all other sections of the domestic water system not being disinfected to prevent migration of chlorine.

5. Prior to injection of chlorine into the piping system, strategically place signs stating “Heavily Chlorinated Water - Do Not Drink”, and protect all outlets to prevent use during disinfection and flushing procedures.

D. A bacteria test is not necessary for small scale work. However, disinfection is required. Examples of small scale work are less than 20 feet of pipe, replacement and/or installation of a sink, drinking fountain, eyewash, backflow preventer, isolation valve, etc. Disinfect individual parts, fixtures, isolation valves, pipes, etc. by swabbing with full strength bleach (5.25%) or soaking for at least 30 minutes in a 500 ppm chlorine solution. The 500 ppm solution can be made by adding one part 5.25% bleach (household bleach) to 100 parts drinking water. For example 3-1/2 ounces of bleach can be added to 2-1/2 gallons drinking water. Materials should then be thoroughly rinsed before putting into service.

END OF SECTION 22 11 16 00

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SECTION 22 11 16 00a - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for sanitary waste and vent piping. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.02 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.
3. Encasement for underground metal piping.

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.04 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).
2. Sanitary Sewer, Force-Main Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.05 SUBMITTALS

1. Product Data: For pipe, tube, fittings, and couplings.
2. LEED Submittal:

a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

3. Shop Drawings:

a. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.

b. Sovent Drainage System: Include plans, elevations, sections, and details.

4. Field quality-control inspection and test reports.

B. Quality Assurance

1. Piping materials shall bear label, stamp, or other markings of specified testing agency.

2. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Refer to Part 1.3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.03 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

4. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.04 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12, galvanized, **as directed**, threaded, cast-iron drainage pattern.

C. Pressure Fittings:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.

2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.

3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, **as directed**, standard pattern.

4. Cast-Iron Flanges: ASME B16.1, Class 125.

5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized, **as directed**.

D. Grooved-Joint Systems:

1. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, **as directed**, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, **as directed**, ductile-iron casting; with dimensions matching steel pipe.

2. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.05 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Gaskets: AWWA C111, rubber.

C. Grooved-Joint Systems:

1. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Flanges: ASME 16.1, Class 125, cast iron.

2.06 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

C. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.07 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.

b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
2. Gasket Material: Natural or synthetic rubber.
3. Metal Component Finish: Corrosion-resistant coating or material.

E. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

F. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

G. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

2.08 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch (0.10-mm) **OR** LLDPE film of 0.008-inch (0.20-mm), **as directed**, minimum thickness.

B. Form: Sheet **OR** Tube, **as directed**.

C. Color: Black **OR** Natural, **as directed**.

PART 3 - EXECUTION

3.01 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings and sovent stack fittings, **as directed**; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** rigid, unshielded, **as directed**, couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
5. Copper DWV tube, copper drainage fittings, and soldered joints.

6. Solid-wall **OR** Cellular-core, **as directed**, ABS pipe, ABS socket fittings, and solvent-cemented joints.

7. Solid-wall **OR** Cellular-core, **as directed**, PVC pipe, PVC socket fittings, and solvent-cemented joints.

8. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **OR** Rigid, unshielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless cast-iron soil pipe and fittings and sovent stack fittings, **as directed**; standard, **OR** heavy-duty, **as directed**, shielded, stainless-steel couplings; and hubless-coupling joints.

3. Steel pipe, drainage fittings, and threaded joints.

4. Solid-wall **OR** Cellular-core, **as directed**, PVC pipe, PVC socket fittings, and solvent-cemented joints.

5. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** rigid, unshielded, **as directed**, couplings; and hubless-coupling joints.

3. Steel pipe, drainage fittings, and threaded joints.

4. Stainless-steel pipe and fittings gaskets, and gasketed joints.

5. Copper DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints.

6. Solid-wall **OR** Cellular-core, **as directed**, ABS pipe, ABS socket fittings, and solvent-cemented joints.

7. Solid-wall **OR** Cellular-core, **as directed**, PVC pipe, PVC socket fittings, and solvent-cemented joints.

8. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **OR** Rigid, unshielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Aboveground, vent piping NPS 5 (DN 125) and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless cast-iron soil pipe and fittings; standard, **OR** heavy-duty, **as directed**, shielded, stainless-steel couplings; and hubless-coupling joints.

3. Steel pipe, drainage fittings, and threaded joints.

4. Solid-wall **OR** Cellular-core, **as directed**, PVC pipe, PVC socket fittings, and solvent-cemented joints.

5. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:

1. Extra-Heavy **OR** Service, **as directed**, class, cast-iron soil piping; gaskets; and gasketed **OR** calking materials; and calked, **as directed**, joints.

2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** heavy-duty shielded, cast-iron **OR** rigid, unshielded, **as directed**, couplings; and hubless-coupling joints.

3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.

4. Cellular-core **OR** Solid wall, **as directed**, ABS pipe, ABS socket fittings, and solvent-cemented joints.

5. Cellular-core **OR** Solid wall, **as directed**, PVC pipe, PVC socket fittings, and solvent-cemented joints.

6. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.

7. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **OR** Rigid, unshielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

G. Underground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:

1. Extra-Heavy **OR** Service, **as directed**, class, cast-iron soil piping; gaskets; and gasketed **OR** calking materials; and calked, **as directed**, joints.

2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** heavy-duty shielded, cast-iron, **as directed**, couplings; and hubless-coupling joints.

3. Cellular-core **OR** Solid-wall, **as directed**, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.

4. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.

5. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) shall be any of the following:

1. Hard copper tube, Type L (Type B) **OR** Type M (Type C), **as directed**; copper pressure fittings; and soldered joints.

2. Steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) shall be any of the following:

1. Hard copper tube, Type L (Type B) **OR** Type M (Type C), **as directed**; copper pressure fittings; and soldered joints.

2. Steel pipe, pressure fittings, and threaded joints.

3. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller shall be any of the following:

1. Hard **OR** Soft, **as directed**, copper tube, Type L (Type B); copper **OR** wrought-copper, **as directed**, pressure fittings; and soldered joints.

2. Steel pipe, pressure fittings, and threaded joints.

    a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

3. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.

    a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

4. Push-on-joint, ductile-iron pipe; push-on-joint ductile-iron fittings; gaskets; and gasketed joints.

    a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

5. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

K. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger shall be any of the following:

1. Steel pipe, pressure fittings, and threaded joints.

2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical-joint joints.

3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron fittings; gaskets; and gasketed joints.

4. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

3.03 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers"

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results For Plumbing".

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105, **as directed**.

G. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

  1. Install encasement on piping according to ASTM A 674 or AWWA C105.

H. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

  1. Install encasement on piping according to ASTM A 674 or AWWA C105.

I. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

  1. Install encasement on piping according to ASTM A 674 or AWWA C105.

J. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results For Plumbing".

OR

K. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

  1. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

    a. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

  2. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

  3. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

C. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.

2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

D. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.

3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

E. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

F. Install ABS soil and waste drainage and vent piping according to ASTM D 2661.

G. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

H. Install underground ABS and PVC soil and waste drainage piping according to ASTM D 2321.

I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.04 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results For Plumbing".

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

F. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

G. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.05 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-duty Valves For Plumbing Piping".

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.

  1. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.

  2. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.

  1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.

  2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.

  3. Install backwater valves in accessible locations.

  4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties".

3.06 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".

B. Pipe hangers and supports are specified in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment". Install the following:

  1. Vertical Piping: MSS Type 8 or Type 42, clamps.

  2. Install individual, straight, horizontal piping runs according to the following:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

    c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

  3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

  4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment".

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

  1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.

  2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.

3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.

4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.

5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.

G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.

3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.

4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.

5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.

6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.

7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.

8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

I. Install supports for vertical steel piping every 15 feet (4.5 m).

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

2. NPS 3 (DN 80): 96 inches (2400 mm) with 1/2-inch (13-mm) rod.

3. NPS 4 (DN 100): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.

4. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.

K. Install supports for vertical stainless-steel piping every 10 feet (3 m).

L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.

2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.

4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.

5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.

6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

M. Install supports for vertical copper tubing every 10 feet (3 m).

N. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.

2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.

3. NPS 4 and 5 (DN 100 and 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.

4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.

5. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

O. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).

P. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main or sanitary manhole.

2. Sewage Pumps: To sewage pump discharge.

3.08 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.09 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PROTECTION

A. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 22 11 16 00a

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SECTION 22 11 16 00b - STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for steam and condensate piping. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.02 SUMMARY

A. This Section includes the following for LP and HP steam and condensate piping:

1. Pipe and fittings.
2. Strainers.
3. Flash tanks.
4. Safety valves.
5. Pressure-reducing valves.
6. Steam traps.
7. Thermostatic air vents and vacuum breakers.
8. Steam and condensate meters.

1.03 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than 15 psig (104 kPa) as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig (104 kPa) or less as required by ASME B31.9.

C. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

D. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.04 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1. HP Steam Piping: <**Insert psig (kPa)**.>
2. LP Steam Piping: <**Insert psig (kPa)**.>
3. Condensate Piping: <**Insert psig (kPa)**> at 250 deg F (121 deg C).
4. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.05 SUBMITTALS

A. Product Data: For each type of the following:

1. RTRP and RTRF with adhesive.
2. Pressure-reducing and safety valve.
3. Steam trap.
4. Air vent and vacuum breaker.
5. Flash tank.
6. Meter.

B. Shop Drawings: Detail, 1/4 inch equals 1 foot (1:50) scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

F. Quality Assurance

1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."
2. Pipe Welding: Qualify processes and operators according to the following:
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. ASME Compliance: Comply with ASME B31.1, "Power Piping" **AND/OR** ASME B31.9, "Building Services Piping", **as directed**, for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

I. Stainless-Steel Bellows, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150-psig (1035-kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.02 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12 (AWS D10.12M) for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.03 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

D. Dielectric Flanges:

1. Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

1. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

2.04 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-duty Valves For Hvac Piping".

B. Stop-Check Valves:

1. Body and Bonnet: Malleable iron.

2. End Connections: Flanged.

3. Disc: Cylindrical with removable liner and machined seat.

4. Stem: Brass alloy.

5. Operator: Outside screw and yoke with cast-iron handwheel.

6. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.

7. Pressure Class: 250.

2.05 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.

3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.

4. Tapped blowoff plug.

5. CWP Rating: 250-psig (1725-kPa) working steam pressure.

B. Basket Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.

3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 250-psig (1725-kPa) working steam pressure.

2.06 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig (1035-kPa) rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.07 SAFETY VALVES

A. Cast-Iron Safety Valves:

1. Disc Material: Forged copper alloy with bronze nozzle.

2. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.

3. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.

4. Pressure Class: 250.

5. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.

6. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.

7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.08 PRESSURE-REDUCING VALVES

A. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

B. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

C. Body: Cast iron.

D. End Connections: Threaded connections for valves NPS 2 (DN 50) and smaller and flanged connections for valves NPS 2-1/2 (DN 65) and larger.

E. Trim: Hardened stainless steel.

F. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

G. Gaskets: Non-asbestos materials.

2.09 STEAM TRAPS

A. Thermostatic Traps:

1. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
2. Trap Type: Balanced-pressure.
3. Bellows: Stainless steel or Monel.
4. Head and Seat: Replaceable, hardened stainless steel.
5. Pressure Class: 125.

B. Thermodynamic Traps:

1. Body: Stainless steel with screw-in cap.
2. End Connections: Threaded.
3. Disc and Seat: Stainless steel.
4. Maximum Operating Pressure: 600 psig (4140 kPa).

C. Float and Thermostatic Traps:

1. Body and Bolted Cap: ASTM A 126, cast iron.
2. End Connections: Threaded.
3. Float Mechanism: Replaceable, stainless steel.
4. Head and Seat: Hardened stainless steel.
5. Trap Type: Balanced pressure.
6. Thermostatic Bellows: Stainless steel or Monel.
7. Thermostatic air vent capable of withstanding 45 deg F (25 deg C) of superheat and resisting water hammer without sustaining damage.
8. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
9. Maximum Operating Pressure: 125 psig (860 kPa).

D. Inverted Bucket Traps:

1. Body and Cap: Cast iron.
2. End Connections: Threaded.
3. Head and Seat: Stainless steel.
4. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
5. Bucket: Brass or stainless steel.
6. Strainer: Integral stainless-steel inlet strainer within the trap body.

7. Air Vent: Stainless-steel thermostatic vent.
8. Pressure Rating: 250 psig (1725 kPa).

2.10 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Body: Cast iron, bronze or stainless steel.
2. End Connections: Threaded.
3. Float, Valve, and Seat: Stainless steel.
4. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
5. Pressure Rating: 125 psig (861 kPa) **OR** 300 psig (2068 kPa), **as directed**.
6. Maximum Temperature Rating: 350 deg F (177 deg C).

B. Vacuum Breakers:

1. Body: Cast iron, bronze, or stainless steel.
2. End Connections: Threaded.
3. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
4. O-ring Seal: EPR.
5. Pressure Rating: 125 psig (861 kPa) **OR** 300 psig (2068 kPa), **as directed**.
6. Maximum Temperature Rating: 350 deg F (177 deg C).

2.11 STEAM METERS

A. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.

1. Computer shall have 4 to 20-mA or 2 to 10 volt output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation described in Division 23 Section "Instrumentation And Control For Hvac".
4. Microprocessor Enclosure: NEMA 250, Type 4.

B. Sensor:

1. Venturi, of stainless-steel **OR** carbon-steel, **as directed**, construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
2. Vortex type with stainless-steel wetted parts and wafer **OR** flange, **as directed**, connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.

3. Spring-loaded, variable-area flowmeter type; density compensated with stainless-steel wetted parts and wafer **OR** flange, **as directed**, connections. At least 10:1 turndown with plus or minus 2 percent accuracy over full-flow range.

2.12 CONDENSATE METERS

A. Body: Cast iron.

B. Turbine: stainless steel.

C. Connections: Threaded for NPS 2 (DN 50) and smaller and flanged for NPS 2-1/2 (DN 65).

D. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.

   1. Computer shall have 4- to 20-mA or 2- to 10-volt output for temperature, pressure, and contact closure for flow increments.

   2. Independent timers to store four peak flow rates and total flow.

   3. Interface compatible with central workstation specified in Division 23 Section "Instrumentation And Control For Hvac".

   4. Microprocessor Enclosure: NEMA 250, Type 4.

E. Pressure Rating: Atmospheric.

F. Maximum Temperature Rating: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.01 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 (DN 50) and Smaller: Schedule 40 **OR** 80, **as directed**, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40 **OR** 80, **as directed**, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. LP Steam Piping, NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

D. LP Steam Piping, NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping above grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:

   1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

   2. RTRP and RTRF with adhesive or flanged joints.

F. Condensate piping above grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:

   1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

2. RTRP and RTRF with adhesive or flanged joints.

G. Condensate piping below grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

2. RTRP and RTRF with adhesive or flanged joints.

H. Condensate piping below grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

2. RTRP and RTRF with adhesive or flanged joints.

3.02 HP STEAM PIPING APPLICATIONS

A. HP Steam Piping, NPS 2 (DN 50) and Smaller: Schedule 40 **OR** 80, **as directed**, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. HP Steam Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40 **OR** 80, **as directed**, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. HP Steam Piping, NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

D. HP Steam Piping, NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping above grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

2. RTRP and RTRF with adhesive or flanged joints.

F. Condensate piping above grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

2. RTRP and RTRF with adhesive or flanged joints.

G. Condensate piping below grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

2. RTRP and RTRF with adhesive or flanged joints.

H. Condensate piping below grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

2. RTRP and RTRF with adhesive or flanged joints.

3.03 ANCILLARY PIPING APPLICATIONS

A. Makeup-water piping installed above grade shall be either of the following, **as directed**:

1. Drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.

2. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings, and solvent welded joints.

B. Makeup-Water Piping Installed below Grade and within Slabs: Annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

C. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

D. Air-Vent Piping:

1. Inlet: Same as service where installed.

2. Outlet: Type K (A) annealed-temper copper tubing with soldered or flared joints.

E. Vacuum-Breaker Piping: Outlet, same as service where installed.

F. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.04 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.05 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) full port-ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using mechanically formed, **as directed**, tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Division 23 Section "General-duty Valves For Hvac Piping".

Q. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and full port ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings And Loops For Hvac Piping".

U. Identify piping as specified in Division 23 Section "Identification For Hvac Piping And Equipment".

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

   1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet (90 m).

   2. Size drip legs same size as main. In steam mains NPS 6 (DN 150) and larger, drip leg size can be reduced, but to no less than NPS 4 (DN 100).

W. Flash Tank:

   1. Pitch condensate piping down toward flash tank.

   2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.

   3. Install thermostatic air vent at tank top.

   4. Install safety valve at tank top.

   5. Install full-port ball valve, and swing check valve on condensate outlet.

6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.

7. Install pressure gage on low-pressure steam outlet according to Division 23 Section "Meters And Gages For Hvac Piping".

3.06 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.07 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on both sides of pressure-reducing valves.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.

E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 23 Section "Meters And Gages For Hvac Piping".

F. Install strainers upstream for pressure-reducing valve.

G. Install safety valve downstream from pressure-reducing valve station.

3.08 STEAM OR CONDENSATE METER INSTALLATION

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's instructions.

B. Provide data acquisition wiring. Refer to Division 23 Section "Instrumentation And Control For Hvac".

3.09 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, "Power Piping" **OR** ASME B31.9, "Building Services Piping," **as directed**

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2 (DN 65).

3.10 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers And Supports For Hvac Piping And Equipment". Comply with requirements below for maximum spacing.

B. Seismic restraints are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

D. Install hangers with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20): Maximum span, 9 feet (2.7 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 1 (DN 25): Maximum span, 9 feet (2.7 m); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1-1/2 (DN 40): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (10 mm).
4. NPS 2 (DN 50): Maximum span, 13 feet (4 m); minimum rod size, 3/8 inch (10 mm).
5. NPS 2-1/2 (DN 65): Maximum span, 14 feet (4.3 m); minimum rod size, 3/8 inch (10 mm).
6. NPS 3 (DN 80): Maximum span, 15 feet (4.6 m); minimum rod size, 3/8 inch (10 mm).
7. NPS 4 (DN 100): Maximum span, 17 feet (5.2 m); minimum rod size, 1/2 inch (13 mm).
8. NPS 6 (DN 150): Maximum span, 21 feet (6.4 m); minimum rod size, 1/2 inch (13 mm).
9. NPS 8 (DN 200): Maximum span, 24 feet (7.3 m); minimum rod size, 5/8 inch (16 mm).
10. NPS 10 (DN 250): Maximum span, 26 feet (8 m); minimum rod size, 3/4 inch (19 mm).
11. NPS 12 (DN 300): Maximum span, 30 feet (9.1 m); minimum rod size, 7/8 inch (22 mm).
12. NPS 14 (DN 350): Maximum span, 32 feet (9.8 m); minimum rod size, 1 inch (25 mm).
13. NPS 16 (DN 400): Maximum span, 35 feet (10.7 m); minimum rod size, 1 inch (25 mm).
14. NPS 18 (DN 450): Maximum span, 37 feet (11.3 m); minimum rod size, 1-1/4 inches (32 mm).
15. NPS 20 (DN 500): Maximum span, 39 feet (11.9 m); minimum rod size, 1-1/4 inches (32 mm).

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 (DN 15): Maximum span, 4 feet (1.2 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
4. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
5. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
6. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
7. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).

F. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

G. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

3.11 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12 (AWS D10.12M), using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.12 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.13 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" **AND/OR** ASME B31.9, "Building Services Piping," **as directed,** and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush system with clean water. Clean strainers.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.

3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

END OF SECTION 22 11 16 00b

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SECTION 22 11 16 00c - GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for general-service compressed-air piping. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.02 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig (1380 kPa) or less.

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. CR: Chlorosulfonated polyethylene synthetic rubber.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. HDPE: High-density polyethylene plastic.

E. NBR: Acrylonitrile-butadiene rubber.

F. PE: Polyethylene plastic.

G. PVC: Polyvinyl chloride plastic.

H. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig (1035 and 1380 kPa).

I. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig (1035 kPa) or less.

1.04 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures.".

1.05 SUBMITTALS

A. Product Data: For the following:

1. Plastic pipes, fittings, and valves.
2. Dielectric fittings.
3. Flexible pipe connectors.
4. Safety valves.
5. Pressure regulators. Include rated capacities and operating characteristics.
6. Automatic drain valves.

7. Filters. Include rated capacities and operating characteristics.

8. Lubricators. Include rated capacities and operating characteristics.

9. Quick couplings.

10. Hose assemblies.

B. Brazing **OR** Welding, **as directed**, certificates.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.06 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.

2. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of compressed-air service.

2. Do not proceed with interruption of compressed-air service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.

1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.

2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.

3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.

4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.

5. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.

6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.

7. Grooved-End Fittings and Couplings:

    a. Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron casting; with grooves according to AWWA C606 and dimensions matching steel pipe.

    b. Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for 300-psig (2070-kPa) minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.

B. Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A or B) seamless, drawn-temper, water tube.

1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.

2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.

3. Copper Unions: ASME B16.22 or MSS SP-123.

4. Press-Type Fittings, NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.

5. Press-Type Fittings, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

6. Extruded-Tee Outlets: Procedure for making branch outlets in copper tube according to ASTM F 2014.

7. Grooved-End Fittings and Couplings:

    a. Grooved-End Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.

    b. Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gasket for oil-free compressed air. Provide NBR gasket if compressed air contains oil or oil vapor.

C. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.02 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.03 VALVES

A. Metal Ball, Butterfly, Check, Gate, and Globe Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping".

2.04 DIELECTRIC FITTINGS

A. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Dielectric Unions: Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

  1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

  2. .

E. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

  1. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.

  2. End Connections, NPS 2 (DN 50) and Smaller: Threaded steel pipe nipple.

  3. End Connections, NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.05 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

  1. Underdeck Clamp: Clamping ring with set screws.

2.06 ESCUTCHEONS

A. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

  1. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

   1. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.

E. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.07 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig (1725-kPa) inlet pressure, unless otherwise indicated.

   1. Type: Pilot operated.

C. Air-Line Pressure Regulators: Diaphragm **OR** Pilot, **as directed**, operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig (1380-kPa) minimum inlet pressure, unless otherwise indicated.

OR

Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig (1380-kPa) minimum inlet pressure, unless otherwise indicated.

D. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated, **as directed**.

E. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated, **as directed**.

F. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated, **as directed**.

G. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal. Include mounting bracket if wall mounting is indicated, **as directed**.

   1. Provide with automatic feed device for supplying oil to lubricator.

2.08 QUICK COUPLINGS

A. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

B. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.

2. Plug End: Flow-sensor-bleeder, check-valve **OR** Straight-through, **as directed**, type with barbed outlet for attaching hose.

C. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.

2. Plug End: With barbed outlet for attaching hose.

2.09 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig (2070-kPa) minimum working pressure, unless otherwise indicated.

1. Hose: Reinforced single **OR** double, **as directed**, -wire-braid, CR-covered hose for compressed-air service.

2. Hose Clamps: Stainless-steel clamps or bands.

3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.

4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

2.10 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; threaded, malleable-iron fittings; and threaded joints.

2. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.

3. NPS 2 (DN 50) and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

4. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.

5. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; threaded, malleable-iron fittings; and threaded joints.

6. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; grooved-end fittings; couplings; and grooved joints.

7. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

8. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.

9. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

10. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; threaded, malleable-iron fittings; and threaded joints.

11. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; grooved-end fittings; couplings; and grooved joints.

12. NPS 5 (DN 125) and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

13. NPS 5 (DN 125) and Larger: Grooved-end, Type K or L (ASTM B 88M Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

B. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; threaded, malleable-iron fittings; and threaded joints.

2. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.

3. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.

4. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; press-type fittings; and pressure-sealed joints.

5. NPS 2 (DN 50) and Smaller: 63-mm and smaller, blue ABS pipe and fittings; transition fittings; valves; and solvent-cemented joints.

6. NPS 2 (DN 50) and Smaller: Green ABS pipe and fittings, transition fittings, and valves; and solvent-cemented joints.

7. NPS 2 (DN 50) and Smaller: HDPE pipe, fittings, and valves; and heat-fusion joints.

8. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; threaded, malleable-iron fittings; and threaded joints.

9. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; grooved-end fittings; couplings; and grooved joints.

10. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.

11. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

12. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; press-type fittings; and pressure-sealed joints.

13. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 90- and 110-mm, blue ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include butterfly valves and flanged joints.

14. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): NPS 3 and NPS 4 (DN 80 and DN 100), green ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include ball valves and flanged joints.

15. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): NPS 3 and NPS 4 (DN 80 and DN 100), HDPE pipe and fittings; valves; and heat-fusion joints.

16. NPS 5 and NPS 6 (DN 125 and DN 150): Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; threaded, malleable-iron fittings; and threaded joints.

17. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; grooved-end fittings; couplings; and grooved joints.

18. NPS 5 to NPS 8 (DN 125 to DN 200): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

C. High-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; threaded, malleable-iron fittings; and threaded joints.

2. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.

3. NPS 2 (DN 50) and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

4. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.

5. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; threaded, malleable-iron fittings; and threaded joints.

6. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; grooved-end fittings; couplings; and grooved joints.

7. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

8. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.

9. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.

10. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

11. NPS 8 (DN 200) and Larger: Schedule 40, black **OR** galvanized, **as directed**, -steel pipe; grooved-end fittings; couplings; and grooved joints.

12. NPS 8 (DN 200) and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

13. NPS 8 (DN 200): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

14. Drain Piping: Use one of the following piping materials:
    a. NPS 2 (DN 50) and Smaller: Type M (Type C) copper tube; wrought-copper fittings; and brazed or soldered joints.
    b. NPS 2 (DN 50) and Smaller: PVC pipe and fittings; and solvent-cemented joints.

3.02 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.

1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section "General-duty Valves For Plumbing Piping" according to the following:
    a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
    b. High-Pressure Compressed Air: Valve types specified for medium-pressure compressed air.
    c. Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
    d. Grooved-end valves may be used with grooved-end piping and grooved joints.

2. Plastic General-Duty Valves: Provide valves, made by piping manufacturer, that are compatible with piping. Do not use plastic valves between air compressors and receivers.
    a. Blue ABS Piping System: Ball and butterfly valves.
    b. Green ABS Piping System: Ball valves.
    c. HDPE Piping System: Ball valves.

3.03 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Install piping adjacent to equipment and machines to allow service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
2. Use cast-copper-alloy companion flange with gasket and brazed **OR** soldered, **as directed**, joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Flanged joints may be used instead of specified joint for any piping or tubing system.

J. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.

K. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

L. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

M. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".

N. Install piping to permit valve servicing.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".

3.04 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.

E. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."

G. Extruded-Tee Outlets for Copper Tubing: Form branches according to ASTM F 2014, with tools recommended by procedure manufacturer, and using operators qualified according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

I. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join according to AWWA C606 for grooved joints. Do not apply lubricant to prelubricated gaskets.

J. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 for socket-fusion joints.

K. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.

L. Solvent-Cemented Joints for ABS Piping: Clean and dry joining surfaces. Join according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. Join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2235 Appendix.

M. Solvent-Cemented Joints for PVC Piping: Clean and dry joining surfaces. Join according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

N. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.05 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping".

B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.

C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.

D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.06 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 (DN 50) and Smaller: Use dielectric unions.

C. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.07 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter, **as directed**, of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.08 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment and tools, **as directed**.

D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.

E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated, **as directed**.

F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated, **as directed**.

G. Install air-line lubricators in branch piping to machine tools. Mount on wall at locations indicated, **as directed**.

H. Install quick couplings at piping terminals for hose connections.

I. Install hose assemblies at hose connections.

3.09 CONNECTIONS

A. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

B. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.10 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.

OR

Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.

1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

D. Install sleeves in new walls and slabs as new walls and slabs are constructed.

E. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
2. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
    a. Seal space outside of sleeve fittings with grout.

F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".

3.11 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:
    a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
    b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
    c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split-casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
    d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.

   e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.

   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

2. Existing Piping:

   a. Chrome-Plated Piping: Split-casting, cast brass with chrome-plated finish.

   b. Insulated Piping: Split-plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.

   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.

   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.

   e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.

   f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.

   g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.12 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

   1. 100 Feet (30 m) or Less: MSS Type 1, adjustable, steel clevis hangers.

   2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

I. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 to NPS 1/2 (DN 8 to DN 15): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/4 to NPS 1-1/4 (DN 20 to DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 (DN 40): 12 feet (3.7 m) with 3/8-inch (10-mm) rod.
4. NPS 2 (DN 50): 13 feet (4 m) with 3/8-inch (10-mm) rod.
5. NPS 2-1/2 (DN 65): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
6. NPS 3 (DN 80): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
7. NPS 3-1/2 (DN 90): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
8. NPS 4 (DN 100): 17 feet (5.2 m) with 5/8-inch (16-mm) rod.
9. NPS 5 (DN 125): 19 feet (5.8 m) with 5/8-inch (16-mm) rod.
10. NPS 6 (DN 150): 21 feet (6.4 m) with 3/4-inch (19-mm) rod.
11. NPS 8 (DN 200): 24 feet (7.3 m) with 3/4-inch (19-mm) rod.
12. NPS 10 (DN 250): 26 feet (7.9 m) with 7/8-inch (22-mm) rod.
13. NPS 12 (DN 300): 30 feet (9.1 m) with 7/8-inch (22-mm) rod.

J. Install supports for vertical, Schedule 40, steel piping every 15 feet (4.6 m).

K. Install hangers for Schedule 5, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/2 (DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
3. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
6. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.

L. Install supports for vertical, Schedule 5, steel piping every 10 feet (3 m).

M. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.

8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

N. Install supports for vertical copper tubing every 10 feet (3 m).

O. Install vinyl-coated hangers for ABS piping with the following maximum horizontal spacing and minimum rod diameters:

1. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F (38 deg C).
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 30 inches (760 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 38 inches (975 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 40 inches (1015 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/4 (DN 32): 45 inches (1140 mm) with 3/8-inch (10-mm) rod.
6. NPS 1-1/2 (DN 40): 52 inches (1330 mm) with 3/8-inch (10-mm) rod.
7. NPS 2 (DN 50): 58 inches (1470 mm) with 3/8-inch (10-mm) rod.
8. NPS 3 (DN 80): 68 inches (1730 mm) with 1/2-inch (13-mm) rod.
9. NPS 4 (DN 100): 76 inches (1900 mm) with 1/2-inch (13-mm) rod.

P. Install supports for vertical ABS piping every 48 inches (1220 mm).

Q. Install vinyl-coated hangers for HDPE piping with the following maximum horizontal spacing and minimum rod diameters:

1. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F (38 deg C).
2. NPS 1/2 (DN 15): 30 inches (760 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 35 inches (890 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 40 inches (1015 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/4 (DN 32): 43 inches (1090 mm) with 3/8-inch (10-mm) rod.
6. NPS 1-1/2 (DN 40): 49 inches (1245 mm) with 3/8-inch (10-mm) rod.
7. NPS 2 (DN 50): 55 inches (1400 mm) with 3/8-inch (10-mm) rod.
8. NPS 3 and NPS 4 (DN 80 and DN 100): 96 inches (2440 mm) with 1/2-inch (13-mm) rod.

R. Install supports for vertical HDPE piping every 48 inches (1220 mm).

3.13 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".

3.14 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Piping Leak Tests for ABS Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 110 deg F (43 deg C) or less, to pressure of 40 psig (275 kPa) above system operating pressure, but not less than 80 psig (550 kPa) **OR** 100 psig (690 kPa), **as directed**, or more than 120 psig (825 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

3. Piping Leak Tests for HDPE Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 100 deg F (38 deg C) or less, to pressure of 40 psig (275 kPa) above system operating pressure, but not less than 100 psig (690 kPa) **OR** 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, or more than 180 psig (1240 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

4. Repair leaks and retest until no leaks exist.

5. Inspect filters, lubricators, and pressure regulators for proper operation.

C. Prepare test reports.

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SECTION 22 11 16 00D - MEDICAL VACUUM AND GAS PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This section includes the furnishing of all labor and materials necessary for complete installation, cleaning, testing and certification of medical vacuum, waste anesthesia gas disposal and gas distribution and monitoring systems, including; piping, inlets, outlets, alarms, valves, supports, labeling, identification and all related accessories. Medical gas systems include Oxygen, Compressed Air, Nitrous Oxide, Carbon Dioxide and Nitrogen.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1.	NFPA 99	Standard for Health Care Facilities
2.	NFPA 70	National Electrical Code
3.	ASTM B819	Seamless Copper Tube for Medical Gas Systems
4.	AWS A5.8	Brazing Filler Metal
5.	CGA V-5	Diameter Index Safety System
6.	Title 25, Texas Administrative Code, Chapter 133, Hospital Licensing	

D. Comply with all Federal and State regulations applicable to this installation.

1.04 QUALITY ASSURANCE

A. All materials, equipment, installation, testing and certification shall be in strict accordance with NFPA 99 for Level 1 Medical–Surgical Vacuum, WAGD and Gases.

B. Manufacturer’s name and pressure rating shall be permanently marked on valve body.

C. Products of same type shall be by one manufacturer. All valves, valve boxes, inlets, outlets, alarms and associated components shall be supplied by a single manufacturer and shall be fully compatible with existing system and service devices.

D. Verify compatibility of all new components with existing system and services.

E. Maintain one copy of each Contract Document on Site.

F. Prior to any installation Work, the installer of medical vacuum and gas piping shall provide and maintain documentation on the job Site for the qualification of brazing procedures and individual brazers as required by NFPA 99.

1.05 SUBMITTALS

A. General:

1. All submitted data shall be specific to this project and identified as such. Generic submittal data will not be accepted.

B. Product Data:

1. Manufacturers descriptive literature, illustrations and installation instructions for all components included within this project indicating compliance with applicable referenced standards, size, dimensions, model number, electrical characteristics and connection requirements.

C. Shop Drawings:

1. Wiring diagrams for medical vacuum and gas alarm systems. Differentiate between manufacturer-installed and field-installed wiring.

D. Record Documents:

1. Record actual locations of piping, valves, alarm sensors, alarm panels, station inlets and outlets.

2. Prepare and provide valve charts.

3. Provide record of test procedures and the results of all tests indicating room and area designations, dates of the tests, and names of persons conducting the tests.

4. Brazer Certificates: Installation Contractor shall present written documentation (less than 1 year old) from a recognized agency trained in administering and testing brazing techniques as per AWS B2.2 or ASME Section IX, certifying that all brazers have been thoroughly trained and tested in the complete installation of medical gas systems.

5. Provide full written description of manufacturer’s warranty.

E. Operation and Maintenance Data:

1. Operation Data: Include manufacturer’s installation and operating instructions.

2. Maintenance Data: Servicing and testing requirements, inspection data, exploded assembly views, Record Documents, inspection data, test reports, installation instructions, replacement part numbers and availability, location and contact numbers of service depot.

1.06 DELIVERY, STORAGE AND HANDLING

A. Tubes, valves, fittings, station outlets, and other piping components in medical gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation in accordance with CGA 4.1, Cleaning Equipment for Oxygen Service, except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

B. Each length of tube shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.

C. Fittings, valves, and other components shall be delivered sealed, labeled, and kept sealed until installation.

D. Where contamination is known to have occurred, the materials affected must be removed and replaced with new materials that are cleaned and sealed by the manufacturer or supplier.

1.07 QUALIFICATIONS

A. General: Companies specializing in manufacturing, installing, testing, certifying and servicing the products and systems specified in this section shall have minimum five years documented experience and be certified as required by the Texas Department of Health and NFPA 99.

B. Manufacturers: Firms regularly engaged in manufacture of medical gas systems equipment and products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years. References may be required.

C. Equipment Supplier: The medical vacuum and gas systems equipment supplier shall provide the services of a manufacturer authorized product specialist to periodically coordinate with the installing Contractor during initial installation of the pipeline systems and have a service organization located within 50 miles of the project Site to provide ongoing service support to MDACC after project completion.

D. Installer: Firm with at least 5 years of successful installation experience on projects with medical gas systems work similar to that required for project. All installations of the medical gas piping systems shall be done only by, or under the direct supervision of a holder of a master plumber license or a journeyman plumber license with a medical gas piping installation endorsement issued by the Texas State Board of Plumbing Examiners. All installers of medical gas system components must be qualified in accordance with the requirements of NFPA 99 and ASSE 6010, Medical Gas Systems Installers Professional Qualifications Standard. In addition, all brazers of medical gas system piping must be qualified in accordance with the requirements of either Section IX, Welding and Brazing Requirements of the ASME Boiler and Pressure Vessel Code, or AWS B2.2, Standard for Brazing Procedure and Performance Qualification.

E. System Verification Testing Agency: Testing shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum pipeline testing and meeting the requirements of ANSI/ASSE Standard 6030, Medical Gas Verifiers Professional Qualifications Standard. Quality control standards of testing agency shall be in strict accordance with American National Standards Institute (ANSI) Q-91. Firm shall be regularly engaged in the testing and certification of similar facilities with a minimum of 5 years of experience.

1.08 SCHEDULING

A. Schedule Work to ensure installation is complete, tested and certified prior to Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 PRESSURIZED MEDICAL GAS PIPING

A. All pipe shall be Type "K", ASTM B819, hard drawn seamless copper medical gas tubing. Pipe shall be identified by the manufacturer’s markings, “OXY,” “MED,” or “OXY/MED” and with size designated reflecting nominal inside diameter.

B. Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Fittings; or brazed fittings complying with MSS SP-73, Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings. Cast copper alloy fittings shall not be permitted.

C. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper–phosphorus or copper–phosphorus–silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8, Specification for Brazing Filler Metal.

D. Threaded joints in medical gas distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.

E. The use of shape memory alloy couplings may be used when making connections to existing piping sizes 2” and smaller. Memory-metal couplings shall have temperature and pressure ratings joints not less than that of a brazed joint. Shape memory alloy couplings shall be manufactured by TW Metals “CryoMed” or Aerofit “CryoFit”.

F. Straight-threaded connections, including unions, flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components shall not be permitted.

G. All pipe and fittings shall be supplied cleaned and sealed for oxygen service.

2.03 MEDICAL VACUUM PIPING

A. All vacuum piping sizes 1-1/2” and smaller shall be as specified for pressurized medical gas pipe. Vacuum pipe sizes 2” and larger shall be Type "K" or “L” hard-drawn seamless copper, either ASTM B 819 medical gas tube or ASTM B 88 water tube.

B. Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Fittings; or brazed fittings complying with MSS SP-73, Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings. Cast copper alloy fittings shall not be permitted.

C. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper–phosphorus or copper–phosphorus–silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8, Specification for Brazing Filler Metal.

D. Threaded joints in medical vacuum distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required, these shall be I.P.S. brass.

E. The use of shape memory alloy couplings may be used when making connections to existing piping sizes 2” and smaller. Memory-metal couplings shall have temperature and pressure ratings joints not less than that of a brazed joint. Shape memory alloy couplings shall be manufactured by TW Metals “CryoMed” or Aerofit “CryoFit”.

F. Mechanically formed, drilled and extruded tee-branch connections shall not be permitted.

G. Couplings and fittings incorporating an O-ring seal shall not be permitted.

H. Roll-grooved joints shall not be permitted.

I. Straight-threaded connections, including unions, flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components shall not be permitted.

2.04 MEDICAL VACUUM AND GAS VALVES

A. General:

1. All valves for pressurized gases and valves for vacuum or WAGD services 1-1/2” and smaller shall be supplied cleaned and sealed (bagged) for oxygen service by the manufacturer.
2. Valves for vacuum or WAGD service sizes 2” and larger will not be required to be cleaned and sealed for oxygen service.
3. Provide quantity and size of valves as indicated on Contract Drawings and as required by NFPA 99.
4. Medical vacuum and gas valves, zone valve boxes and related accessories shall be manufactured by BeaconMedaes.

B. Source, Main, Riser and Service Line Shut-Off Valves:

1. Shut-off valves shall be full port, double seal, ball-type three piece design, designed for vacuum to 29 inches Hg and working pressures up to 600 WOG with bronze/brass body, blow-out proof stem and chrome plated brass ball and be serviceable in the line. Valve body shall have Teflon (TFE) material ball seat and stem seals. Seats/seals, lubricants and valve material shall be compatible with medical oxygen, nitrous oxide, compressed air, carbon dioxide, nitrogen and mixtures thereof at continuous pressure up to 600 psig and up to 100 degrees Fahrenheit.
2. Valve shall be provided with and operated by a lever-type handle requiring only a quarter turn from a fully open position to a fully closed position.
3. All valves shall be equipped with type "K" washed and degreased copper pipe stub extensions at both the inlet and outlet sides of the valve port to facilitate installation. On outlet pipe stub provide 1/8” FPT tap with plug to accept gauge or nitrogen purge connection. Stub extensions shall be supplied to Site capped at both ends
4. Valve tags showing the appropriate gas services, pressure rating, etc. shall be attached to each valve.
5. Each shut-off valve shall be provided with locking kit.

C. Zone Valve and Box Assemblies:

1. Each zone valve cabinet shall be recessed type and consist of the following components: A steel valve box housing single or multiple shut-off ball valves with tube extensions, an aluminum frame, and a pull-out removable window. Boxes shall be provided to accommodate size and type of medical vacuum and gas valves as indicated on Contract Drawings.
2. The valve box shall be constructed of 18 gauge steel complete with a white epoxy finish and provided with two galvanized steel brackets for the purpose of mounting to structural support. The assembly trim shall accommodate various finished wall thickness of up to one inch and be field adjustable. Cabinets shall be designed to permit box assemblies to be ganged together in a vertical stack.
3. The doorframe assembly shall be constructed of anodized aluminum mounted to the back box assembly by screws as provided and shall have a sliding removable front consisting of an opaque door with a pre-mounted pullout ring and clear gauge window. Access to the zone shut-off valves shall be by merely pulling the ring assembly to remove the window from the doorframe. The window shall be capable of re-installation without the use of tools and only after the valve handles have been returned to the open position. The window shall be labeled "Caution – Medical Gas Shut-Off Valve - Close Only in Emergency", or equivalent wording in accordance with NFPA 99.

4. Valves shall be same as specified herein for line shut-off valves except locking devices are not required.

5. Each valve shall be supplied with an identification bracket bolted directly onto the valve body for the purpose of applying an approved medical gas identification label. A package of labels shall be supplied with each valve box assembly for application by the installer.

6. All valves shall be securely attached to the box and provided with Type "K" washed and degreased copper pipe stub extensions of sufficient length to protrude beyond the sides of the box for connection to system piping. All pipe stub extensions shall be supplied with 1/8" NPT gauge port located on the terminal outlet side of the valve to register pipeline pressure or vacuum. Suitable plugs or caps shall be installed by the manufacturer to prevent contamination of the assembly prior to installation.

7. Gauges shall be minimum 1-1/2" diameter, with metal case and ring, and an 1/8" NPT brass stud at the back of the gauge for the purpose of mounting onto pipe stub extension within the box. The pipe stub extension shall be complete with a soldered gauge holder. Gauge holders shall be sealed with a brass plug to prevent contamination prior to mounting gauges. Pressure gauges shall read 0-700 kPa (0-100 psig) for all gases except nitrogen, which shall read 0-2000 kPa (0-300 psig), and vacuum, which shall read -100-0 kPa (0-30" Hg). Gauges shall be visible through the door of the zone valve box.

2.05 MEDICAL VACUUM AND GAS CHECK VALVES

A. Check valves shall be center guided, self-aligning, spring loaded ball type check with brass body, Teflon seat, straight-through flow, 400 psi WOG minimum working pressure, having vibration free, silent operation.

B. Check valves shall be 100% leak tested and comply with NFPA 99.

2.06 SERVICE INLETS AND OUTLETS

A. General:

1. Inlets and outlets shall be UL listed and conform to applicable NFPA and CGA standards.

2. Inlets and outlets shall consist of separate roughing-in and finish assemblies and be modular in design for wall recessed type installation and attachment to concealed piping.

3. For positive pressure gas services, the outlet shall be equipped with a primary and secondary check valve. The secondary check valve shall be rated at a minimum 1379 KPa (200 psi) in the event the primary check valve is removed for maintenance.

4. The roughing-in assembly shall be corrosion resistant with a permanent pin-keying system for each specific gas and be provided with a Type "K", 1/2" outside diameter, 6-1/2" long copper inlet pipe stub, which is silver brazed to the outlet body. The copper tubing inlet shall rotate 360 degrees to allow connection from any direction. The assembly shall allow pressure testing without additional labor to remove plug or adapter after testing.

5. The finishing assembly shall contain a primary check valve, pin-key indexing, a minimum of 2.5 square inches of color coding and incorporate a plaster adjustment from 3/8" to 3/4" variation in wall thickness. Design shall be such as to ensure absolutely no gas flow until the correct adapter is fully engaged. Each assembly shall have a separate cover plate for ease of service without preventing use of other inlets or outlets.

6. All inlets and outlets shall be factory assembled, tested, cleaned for oxygen service, and supplied with temporary protective covers and packages to protect outlet during handling and installation at the job Site.

7. Medical inlets and outlets and related accessories shall be manufactured by BeaconMedaes.

B. Wall Inlets:

1. Wall inlets for Waste Anesthesia Gas Disposal (WAGD) services shall be quick-connect recessed type and be compatible with Medaes Diamond style pin indexed adapters.
2. Wall inlets for Vacuum services shall be Diameter Index Safety System (DISS) recessed type and only accept corresponding DISS type gas specific adapters.
3. Each vacuum outlet shall have an adjacent slide for supporting vacuum bottle assembly.

C. Wall Outlets:

1. Wall outlets for oxygen, nitrous oxide, nitrogen, carbon dioxide and medical compressed air service shall be Diameter Index Safety System (DISS) recessed type and only accept corresponding DISS type gas specific adapters.

D. Ceiling Inlets and Outlets with Hose Drops:

1. Ceiling outlets for oxygen, nitrous oxide, medical compressed air, vacuum and evacuation services shall be Diameter Index Safety System (DISS) recessed type and only accept corresponding DISS type gas specific adapters.
2. Provide an upper hose assembly with a reel-type retractor kit. Hose shall terminate 6'-4" above finished floor.
3. Hose assembly shall consist of a UL-listed high-pressure color-coded conductive hose with a DISS nut and gland on the upper end. Provide a DISS Hand-I-Twist check unit on the lower end for all services except WAGD. Provide a Diamond quick-connect on the lower end for the Waste Anesthesia Gas Disposal service.

2.07 MEDICAL VACUUM AND GAS ALARMS

A. General:

1. Provide master alarms for source equipment as indicated on Contract Drawings and as required by NFPA 99.
2. Provide area alarms for station inlets and outlets as indicated on Contract Drawings and as required by NFPA 99.
3. Alarms shall provide signals as required by the latest edition of NFPA 99. Alarms shall be listed to UL 1069 and CSA C22.2 NO 601.1-M90 and comply with the following electromagnetic compatibility standards: FCC Part 15 Class A, ICES 003 Class A, EN 61326, EN 61000-3-2 and EN 61000-3-3.
4. All field wiring and signals shall be self-monitoring and on a closed circuit. Fault signals shall activate on an open circuit.
5. Input power to the alarm panel shall be 100 to 250 VAC 50/60 Hz, double fused on the input side. An internal power supply shall convert the input voltage to low voltage +5 and +24 VDC. All user accessible electronics and wiring shall utilize low voltage. A guard must be removed to access the high voltage wiring.
6. A green front panel POWER ON indicator shall illuminate when the alarm panel is powered. Each monitored condition shall have a separate red indicator illuminated when in alarm. A red indicator on the alarm silence button shall be illuminated after any audible alarm has been silenced.

7. Each panel shall provide an audible signal activated by digital display modules or multi-signal alarm modules. The audible signal shall produce a minimum sound pressure level of 90 dBA measured at a distance of 3 feet. The alarm panel shall contain alarm silence, test, and setup buttons.

8. Each panel shall include a general fault relay for the entire panel, an RS-485 data port and an additional auxiliary relay.

9. Medical gas alarm panels, sensors and related accessories shall be manufactured by BeaconMedaes.

B. Area Alarms

1. Area alarm panels shall be provided to monitor all medical gas, medical/surgical vacuum, and piped WAGD systems supplying anesthetizing locations, and other vital life support and critical areas such as post anesthesia recovery, intensive care units, emergency departments, and where indicated on Contract Drawings.

2. Digital display modules shall provide a digital LED display continuously indicating the pressure or vacuum in the piping system being monitored. The brightness of the LED display shall be adjustable to compensate for ambient lighting. The display shall be programmable to read psig, in Hg, mm Hg, or kPa in increments of 1 psig, 1 in Hg, 1 mm Hg, or 1 kPa respectively.

3. The digital display module shall provide an audible and visual signal when a fault condition occurs. A front panel alarm mute button shall be provided to silence the audio. A visual signal shall flash until the alarm silence button is pressed, and shall then remain statically illuminated. The visual signal shall automatically cancel when the fault is corrected.

4. Separate visual signals for system pressure or vacuum are NORMAL (green LED), LOW (red LED), and HIGH (red LED). Signal limits are factory set per NFPA 99 and field programmable without the use of tools. Pressing and holding the front panel TEST button initiates a self-test function to test the LED display, visual indicators, audible alarm, and to view the alarm set points.

5. Each digital display module shall be equipped with separate relays for high and low alarms. Relays shall be single-pole double-throw type (30 VAC/VDC 2A max). Digital readings from one display module shall be capable of being monitored by another digital display module at a remote panel.

6. A sensor module shall be provided for each digital display module. Sensor modules shall contain a transducer capable of providing calibrated signals to the digital display module. Sensor modules shall be gas specific. The alarm panel shall be factory configured for sensor mounting within the alarm panel rough-in box (local sensors) or mounting above ceiling directly to the medical gas pipeline (remote sensors). Remote sensors may be located up to 1524 m (5,000 feet) from the alarm panel.

7. Pipeline connections shall be 3/8” nominal (1/2” OD) Type “K” copper tube. Connectors shall be provided for attaching field wiring. Sensors shall be gas specific for periodic testing without interrupting medical gas pipeline pressures or vacuum.

C. Master Alarms

1. A master alarm system shall be provided to monitor the operation and condition of the source of supply, the reserve source, and the pressure in the main lines of each medical vacuum and gas piping system. The master alarm system shall consist of two or more alarm panels located in at least two separate locations as required by NFPA 99.

2. Each Multi-signal alarm module shall be capable of monitoring up to five dry-contact signals. Each signal shall illuminate a green LED to indicating normal conditions. When a fault occurs, the green LED shall turn off, a red LED shall illuminate, and an audible alarm shall sound. The red LED shall flash until the front panel alarm silence button is pressed. After the alarm silence button is pressed, the red LED shall remain statically illuminated. The red indicator shall automatically turn off and the green LED shall illuminate when the fault is corrected.

3. LED illumination for unused signals shall be deactivated in the field. Field programming shall be accomplished without the use of tools. Pressing and holding the front panel TEST button shall initiate a self-test function to test the LED indicators and audible alarm. The multi-signal module shall be supplied with five, dry-contact, normally closed relays for connection to a building automation system. Relay ratings shall be 30 VAC/VDC 2A max.

4. A blank overlay shall be used to fill unused alarm panel locations and/or reserve a module location for future expansion. It shall be removable for installing additional modules.

D. Vacuum and Pressure Switches

1. Switches shall incorporate UL listed single-pole, double-throw, and snap-action switching elements. Switch shall automatically reset.

2. Switches shall be housed in a watertight NEMA 4 enclosure with tamper-resistant external adjustment.

3. Signal setting for low vacuum shall be at 12” HG.

4. Signal settings for all pressure gases except Nitrogen shall be; Low – 40 psig, High – 60 psig.

5. Signal settings for Nitrogen gas shall be; Low – 140 psig, High – 190 psig.

6. Pressure switches shall be cleaned and sealed for oxygen service.

2.08 LINE GAUGES

A. General:

1. Gauges shall comply with ANSI/ASME B-40.1 and be constructed of materials compatible with medical vacuum and gas applications. Pressure indicators for medical gas piping systems shall be cleaned for oxygen service.

2. Gauge housings shall be drawn steel with black, corrosion-resistant paint. Dial shall be 4-1/2” in diameter with white background and black markings. Pointer shall be aluminum with black finish. Gauge movement shall be brass construction. Bottom of gauge shall be provided with ¼” – 18 NPT – 2A brass connection.

3. Indicators adjacent to master alarm actuators and area alarms shall be labeled to identify the name of or chemical symbol for the particular piping system that they monitor.

4. Provide Diameter Index Safety System connection kits with all appropriate fittings for connecting gauges to pipelines.

B. Medical vacuum and gas line gauges and DISS connection kits shall be manufactured by BeaconMedaes.

C. Vacuum Line Gauges

1. Vacuum bourbon tube shall be beryllium copper and soft soldered.

2. Gauge shall register 0 – 30 inches HG.

D. Pressure Line Gauges

1. Pressure bourbon tube shall be phosphor bronze and soft soldered.
2. Gauge shall register 0 – 100 psig for all medical gases except Nitrogen.
3. Gauge shall register 0 – 300 psig for Nitrogen gas.
4. Gauges for positive pressure gases shall be cleaned and sealed for oxygen service.

2.09 UNDERGROUND WARNING TAPE

A. Minimum 3 inch wide polyethylene detectable type marking tape. The tape shall be resistant to alkalis, acids and other destructive agents found in soil and impregnated with metal so that it can be readily recognized after burial by standard locating equipment.

1. Lamination bond of 1 layer of Minimum 0.35 mils thick aluminum foil between 2 layers of minimum 4.3 mils thick inert plastic film.
2. Minimum tensile strength: 63 LBS per 3 IN width.
3. Minimum elongation: 500 percent.
4. Provide continuous yellow with black letter printed message repeated every 16 to 36 inches warning of pipe by specific name buried below (e.g.: "CAUTION OXYGEN LINE BURIED BELOW").
5. Manufactured by Reef Industries “Terra Tape” or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install all system components in complete compliance with referenced standards and manufacturer’s published instructions.

D. Exercise great care in the storage and handling of all materials and in the condition of tools used in cutting and reaming to prevent oil or grease or any contaminants from being introduced into tubing. The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service by the manufacturer, but become contaminated prior to being installed, shall be recleaned on-Site by the installer by thoroughly scrubbing the interior surfaces with a clean, hot water–alkaline solution, such as sodium carbonate or trisodium phosphate 450 g to 11 L (1 lb. to 3 gal) of potable water and thoroughly rinsing them with clean, hot potable water. Material that has become contaminated internally and is not clean for oxygen service shall not be installed.

E. The exterior surface of all tubes, joints and fittings shall be cleaned prior to brazing with non-abrasive pads by washing with hot water after assembly to remove any surface oxides or excess flux and provide for clear visual inspection of brazed connections. A visual inspection of each brazed joint shall be made to assure that the alloy has flowed completely around the joint at the tube-fitting interface. Where flux has been used, assure that solidified flux residue has not formed a temporary seal that could hold test pressure.

F. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside of completed joints. (NOTE: Ensure proper ventilation. Some BAg series filler metals contain cadmium, which, when heated during brazing, can produce toxic fumes.)

G. Joints shall be brazed within one hour after the surfaces are cleaned for brazing.

H. While being brazed, all vacuum and oxygen piping joints shall be continuously purged with oil-free, dry Nitrogen to prevent the formation of copper oxide on the inside surfaces of the joint. The purge shall be maintained until the joint is cool to the touch. The final connection of new piping to an existing, in-use pipeline shall be permitted to be made without the use of a nitrogen purge.

I. Bury all underground piping at least 3 feet below finished grade and fully encase within schedule 40 PVC piping sleeve. Provide a continuous detectable warning tape immediately above buried lines. Warning tape shall clearly identify the pipeline by specific name. A continuous warning means shall also be provided on tamped backfill above the pipeline at approximately one-half the depth of bury.

J. Do not install piping in the same trench with other buried utilities. The minimum horizontal clearance between medical pipe and parallel buried utility pipe shall be 8 feet. Do not install pipe through catch basins, vaults, manholes or similar underground structures.

K. Piping systems for gases shall not be used as a grounding electrode.

L. Piping shall not be installed in kitchens, electrical switchgear rooms, elevator shafts, and areas with open flames.

M. Memory-metal couplings shall not be installed within eight inches of a brazed joint.

N. Shut-off valves installed for future connections shall be provided with downstream piping closed with a brazed cap and sufficient tubing allowance for cutting and re-brazing.

O. Branch takeoffs from horizontal piping shall be taken off above the centerline of the main or branch pipe and rise vertically or at an angle of not less than 45 degrees from vertical.

P. Support all piping in accordance with NFPA 99 and Contract Documents.

Q. Pressure and vacuum indicators shall be readable from a standing position.

R. Zone valve boxes shall be installed where they are visible and accessible at all time and readily operable from a standing position in the corridor on the same floor they serve.

S. Area alarm panels shall be located where indicated on Contract Drawings at a nurse’s station or other location that will provide for continuous responsible surveillance.

T. Locate master alarm panels shall where indicated on Contract Drawings in at least two separate locations as required by NFPA 99.

U. All alarm panels shall be mounted at a height allowing monitoring and operation from a standing position.

V. Coordinate with Electrical Contractor to insure that power is provided to alarms from the life safety branch of the emergency electrical system as described in NFPA 99.

W. Provide low voltage wiring from sensors to alarm panels as required by NFPA 99. All low voltage wiring shall be routed within conduit. Wiring from switches or sensors shall be supervised or protected as required by NFPA 70, National Electrical Code, for emergency system circuits.

3.02 LABELING

A. Label all piping, valves, station inlets and outlets, and alarms in accordance with NFPA 99 requirements and Contract Documents.

B. Re-label existing shut-off valves and alarm panels when modifications are made changing the areas served. New labels shall be in accordance with NFPA 99 and Contract Documents.

3.03 TESTING AND INSPECTION

A. Inspection and testing shall be performed on all new piped gas systems, additions, renovations, temporary installations, or repaired systems, to assure the facility, by a documented procedure, that all applicable provisions of NFPA 99 have been adhered to and system integrity has been achieved or maintained.

B. After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and permit clear visual inspection of the joint. Each brazed joint shall be visually inspected after cleaning the outside surfaces. Brazed joints identified as defective shall be repaired or replaced as required by NFPA 99.

C. After installation of the distribution piping and before installation of station outlets/inlets and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators), piping in medical vacuum and gas distribution systems shall be blown clear by means of oil-free, dry Nitrogen.

D. Installer shall perform initial pressure tests, cross-connection test, piping purge test and standing pressure test prior to third party system verification and in strict accordance with NFPA 99.

E. The rated accuracy of indicators used for testing shall be 1 percent (full scale) or better at the point of reading.

F. System verification tests shall be performed only after all installer performed tests, have been completed. Equipment Vendor or installing Contractor shall not perform system verification, final testing or certification.

G. A Third Party Medical Gas System Verification Testing Agency shall perform standing pressure test, cross-connection test, valve test, alarm test, piping purge test, piping particulate test, piping purity test, final tie-in test, operational pressure test and medical gas concentration test.

H. The Third Party Medical Gas System Verification Testing Agency shall verify the presence and correctness of labeling required by this standard for all components (e.g., station outlets/inlets, shutoff valves, and alarm panels).

I. It shall be the responsibility of the Third Party Medical Gas System Verification Testing Agency to make periodic job Site visits to assure all requirements of this specification and NFPA 99 are strictly adhered to.

J. Certification shall clearly state that the system is approved for patient use and meets all requirements of NFPA-99 inclusive of all referenced and/or related documents. Any exceptions or limitations shall be clearly stated on the same certification document.

3.04 VENDOR SUPERVISION AND OPERATING INSTRUCTIONS

A. An authorized representative of the equipment manufacturer shall periodically check with the installing Contractor during initial installation of the pipeline systems and equipment and shall assist the Contractor in final check to make certain that all systems are operating as recommended by the manufacturer, as specified and in accordance with NFPA 99. The equipment manufacturer's representative shall provide a minimum of 4 hours instruction to MDACC personnel in the use of the piping systems and the related equipment operated from those systems.

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SECTION 22 11 19 00 - LABORATORY VACUUM AND GAS PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This section includes the furnishing of all labor and materials necessary for complete installation, cleaning, testing and certification of laboratory vacuum, waste anesthesia gas disposal and gas distribution and monitoring systems, including; piping, inlets, outlets, alarms, valves, supports, labeling, identification and all related accessories. Laboratory gas systems include Oxygen, Compressed Air, Nitrous Oxide, Carbon Dioxide and Nitrogen.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. NFPA 99 Standard for Health Care Facilities.
2. NFPA 70ASTM B819 Seamless Copper Tube for Medical Gas Systems.
3. AWS A5.8 Brazing Filler Metal.
4. CGA V-5 Diameter Index Safety System.

D. Comply with all Federal and State regulations applicable to this installation.

1.04 QUALITY ASSURANCE

1. All materials, equipment, installation, testing and certification shall be in strict accordance with NFPA 99 for Level 1 Medical–Surgical Vacuum, WAGD and Gases.
2. Manufacturer’s name and pressure rating shall be permanently marked on valve body.
3. Products of same type shall be by one manufacturer. All valves, valve boxes, inlets, outlets, alarms and associated components shall be supplied by a single manufacturer and shall be fully compatible with existing system and service devices.
4. Verify compatibility of all new components with existing system and services.
5. Maintain one copy of each Contract Document on Site.
6. Prior to any installation Work, the installer of laboratory vacuum and gas piping shall provide and maintain documentation on the job Site for the qualification of brazing procedures and individual brazers as required by NFPA 99.

1.05 SUBMITTALS

A. General:

1. All submitted data shall be specific to this project and identified as such. Generic submittal data will not be accepted.

B. Product Data:

1. Manufacturers descriptive literature, illustrations and installation instructions for all components included within this project indicating compliance with applicable referenced standards, size, dimensions, model number, electrical characteristics and connection requirements.

C. Shop Drawings:

1. Wiring diagrams for laboratory vacuum and gas alarm systems. Differentiate between manufacturer-installed and field-installed wiring.

D. Record Documents:

1. Record actual locations of piping, valves, alarm sensors, alarm panels, station inlets and outlets.

2. Prepare and provide valve charts.

3. Provide record of test procedures and the results of all tests indicating room and area designations, dates of the tests, and names of persons conducting the tests.

4. Brazer Certificates: Installation Contractor shall present written documentation (less than 1 year old) from a recognized agency trained in administering and testing brazing techniques as per AWS B2.2 or ASME Section IX, certifying that all brazers have been thoroughly trained and tested in the complete installation of medical gas systems.

5. Product Certificates: The installer shall furnish documentation certifying that all installed pipe, valves, fittings, station outlets, and other piping components in laboratory gas systems shall have been cleaned for oxygen service in accordance with CGA 4.1, Cleaning Equipment for Oxygen Service and NFPA 99. Submit letter signed by manufacturer certifying that copper tubing complies with NFPA 99. Submit letter from manufacturer stating that station outlets and inlets are designed and manufactured to comply with NFPA 99. Outlet and inlet shall bear label of approval as an assembly, by Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation.

6. Inspection and Test Reports: Furnish documentation that all installer inspections and tests required by NFPA 99 for Level 1 Medical–Surgical Vacuum, WAGD and Gases have been performed. Identify test type, procedure and results.

7. Independent Third Party System Verification Testing Agency Reports and Certification: Documentation verifying that completed systems have been installed, tested, purged, and analyzed in accordance with the requirements of referenced standards and contract documents. Provide copy of agency’s written Q-91 standards.

8. Provide full written description of manufacturer’s warranty.

E. Operation and Maintenance Data:

1. Operation Data: Include manufacturer’s installation and operating instructions.

2. Maintenance Data: Servicing and testing requirements, inspection data, exploded assembly views, Record Documents, inspection data, test reports, installation instructions, replacement part numbers and availability, location and contact numbers of service depot.

1.06 DELIVERY, STORAGE AND HANDLING

A. Tubes, valves, fittings, station outlets, and other piping components in laboratory gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation in accordance with CGA 4.1, Cleaning Equipment for Oxygen Service, except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

B. Each length of tube shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.

C. Fittings, valves, and other components shall be delivered sealed, labeled, and kept sealed until installation.

D. Where contamination is known to have occurred, the materials affected must be removed and replaced with new materials that are cleaned and sealed by the manufacturer or supplier.

1.07 QUALIFICATIONS

A. General: Companies specializing in manufacturing, installing, testing, certifying and servicing the products and systems specified in this section shall have minimum five years documented experience and be certified as required by the Texas Department of Health and NFPA 99.

B. Manufacturers: Firms regularly engaged in manufacture of medical vacuum and gas systems equipment and products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years. References may be required.

C. Equipment Supplier: The laboratory vacuum and gas systems equipment supplier shall provide the services of a manufacturer authorized product specialist to periodically coordinate with the installing Contractor during initial installation of the pipeline systems and have a service organization located within 50 miles of the project Site to provide ongoing service support to M. D. Anderson Cancer Center after project completion.

D. Installer: Firm with at least 5 years of successful installation experience on projects with medical vacuum and gas systems work similar to that required for project. All installations of the piping systems shall be done only by, or under the direct supervision of a holder of a master plumber license or a journeyman plumber license with a medical gas piping installation endorsement issued by the Texas State Board of Plumbing Examiners. All installers of laboratory vacuum and gas system components must be qualified in accordance with the requirements of NFPA 99 and ASSE 6010, Medical Gas Systems Installers Professional Qualifications Standard. In addition, all brazers of laboratory gas system piping must be qualified in accordance with the requirements of either Section IX, Welding and Brazing Requirements of the ASME Boiler and Pressure Vessel Code, or AWS B2.2, Standard for Brazing Procedure and Performance Qualification.

E. System Verification Testing Agency: Testing shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum pipeline testing and meeting the requirements of ANSI/ASSE Standard 6030, Medical Gas Verifiers Professional Qualifications Standard. Quality control standards of testing agency shall be in strict accordance with American National Standards Institute (ANSI) Q-91. Firm shall be regularly engaged in the testing and certification of similar facilities with a minimum of 5 years of experience.

1.08 SCHEDULING

A. Schedule Work to ensure installation is complete, tested and certified prior to Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 PRESSURIZED LABORATORY GAS PIPING

A. All pipe shall be Type "K", ASTM B819, hard drawn seamless copper medical gas tubing. Pipe shall be identified by the manufacturer’s markings, “OXY,” “MED,” or “OXY/MED” and with size designated reflecting nominal inside diameter.

B. Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Fittings; or brazed fittings complying with MSS SP-73, Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings. Cast copper alloy fittings shall not be permitted.

C. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper–phosphorus or copper–phosphorus–silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8, Specification for Brazing Filler Metal.

D. Threaded joints in laboratory gas distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.

E. The use of shape memory alloy couplings is may be used when making connections to existing piping sizes 2” and smaller. Memory-metal couplings shall have temperature and pressure ratings joints not less than that of a brazed joint. Shape memory alloy couplings shall be manufactured by TW Metals “CryoMed” or Aerofit “CryoFit”.

F. Straight-threaded connections, including unions, flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components shall not be permitted.

G. All pipe and fittings shall be supplied cleaned and sealed for oxygen service.

2.03 LABORATORY VACUUM PIPING

A. All vacuum piping sizes 1-1/2” and smaller shall be as specified for pressurized laboratory gas pipe. Vacuum pipe sizes 2” and larger shall be Type "K" or “L” hard-drawn seamless copper, either ASTM B 819 medical gas tube or ASTM B 88 water tube.

B. Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Fittings; or brazed fittings complying with MSS SP-73, Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings. Cast copper alloy fittings shall not be permitted.

C. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper–phosphorus or copper–phosphorus–silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8, Specification for Brazing Filler Metal.

D. Threaded joints in laboratory vacuum distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required, these shall be I.P.S. brass.

E. The use of shape memory alloy couplings is may be used when making connections to existing piping sizes 2” and smaller. Memory-metal couplings shall have temperature and pressure ratings joints not less than that of a brazed joint. Shape memory alloy couplings shall be manufactured by TW Metals “CryoMed” or Aerofit “CryoFit”.

F. Mechanically formed, drilled and extruded tee-branch connections shall not be permitted.

G. Couplings and fittings incorporating an O-ring seal shall not be permitted.

H. Roll-grooved joints shall not be permitted.

I. Straight-threaded connections, including unions, flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components shall not be permitted.

2.04 LABORATORY VACUUM AND GAS VALVES

A. General:

1. All valves for pressurized gases and valves for vacuum or WAGD services 1-1/2” and smaller shall be supplied cleaned and sealed (bagged) for oxygen service by the manufacturer.

2. Valves for vacuum or WAGD service sizes 2” and larger will not be required to be cleaned and sealed for oxygen service.

3. Provide quantity and size of valves as indicated on Contract Drawings and as required by NFPA 99.

4. Laboratory vacuum and gas valves, zone valve boxes and related accessories shall be manufactured by BeaconMedaes.

B. Source, main, riser and service line shut-off valves shall

1. Shut-off valves shall be full port, double seal, ball-type three piece design, designed for vacuum to 29 inches Hg and working pressures up to 600 WOG with bronze/brass body, blow-out proof stem and chrome plated brass ball and be serviceable in the line. Valve body shall have Teflon (TFE) material ball seat and stem seals. Seats/seals, lubricants and valve material shall be compatible with oxygen, nitrous oxide, compressed air, carbon dioxide, nitrogen and mixtures thereof at continuous pressure up to 600 psig and up to 100 degrees Fahrenheit.

2. Valve shall be provided with and operated by a lever-type handle requiring only a quarter turn from a fully open position to a fully closed position.

3. All valves shall be equipped with type "K" washed and degreased copper pipe stub extensions at both the inlet and outlet sides of the valve port to facilitate installation. On outlet pipe stub provide 1/8” FPT tap with plug to accept gauge or nitrogen purge connection. Stub extensions shall be supplied to Site capped at both ends

4. Valve tags showing the appropriate gas services, pressure rating, etc. shall be attached to each valve.

5. Each shut-off valve shall be provided with locking kit.

C. Zone Valve and Box Assemblies:

1. Each zone valve cabinet shall be recessed type and consist of the following components: A steel valve box housing single or multiple shut-off ball valves with tube extensions, an aluminum frame, and a pull-out removable window. Boxes shall be provided to accommodate size and type of vacuum and gas valves as indicated on Contract Drawings.

2. The valve box shall be constructed of 18 gauge steel complete with a white epoxy finish and provided with two galvanized steel brackets for the purpose of mounting to structural support. The assembly trim shall accommodate various finished wall thickness of up to one inch and be field adjustable. Cabinets shall be designed to permit box assemblies to be ganged together in a vertical stack.

3. The doorframe assembly shall be constructed of anodized aluminum mounted to the back box assembly by screws as provided and shall have a sliding removable front consisting of an opaque door with a pre-mounted pullout ring and clear gauge window. Access to the zone shut-off valves shall be by merely pulling the ring assembly to remove the window from the doorframe. The window shall be capable of re-installation without the use of tools and only after the valve handles have been returned to the open position. The window shall be labeled "Caution – Laboratory Gas Shut-Off Valve - Close Only in Emergency", or equivalent wording in accordance with NFPA 99.

4. Valves shall be same as specified herein for line shut-off valves except locking devices are not required.

5. Each valve shall be supplied with an identification bracket bolted directly onto the valve body for the purpose of applying an approved identification label. A package of labels shall be supplied with each valve box assembly for application by the installer.

6. All valves shall be securely attached to the box and provided with Type "K" washed and degreased copper pipe stub extensions of sufficient length to protrude beyond the sides of the box for connection to system piping. All pipe stub extensions shall be supplied with 1/8" NPT gauge port located on the terminal outlet side of the valve to register pipeline pressure or vacuum. Suitable plugs or caps shall be installed by the manufacturer to prevent contamination of the assembly prior to installation.

7. Gauges shall be minimum 1-1/2” diameter, with metal case and ring, and an 1/8" NPT brass stud at the back of the gauge for the purpose of mounting onto pipe stub extension within the box. The pipe stub extension shall be complete with a soldered gauge holder. Gauge holders shall be sealed with a brass plug to prevent contamination prior to mounting gauges. Pressure gauges shall read 0-700 kPa (0-100 psig) for all gases except nitrogen, which shall read 0-2000 kPa (0-300 psig), and vacuum, which shall read -100-0 kPa (0-30" Hg). Gauges shall be visible through the door of the zone valve box.

2.05 SERVICE INLETS AND OUTLETS

A. General:

B. For Gas, Air and Vac valves, UT Health specify Chicago 909 series valves, but they need to be specified so the proper service indicated. If the GAV are deck mounted, we specify Chicago turrets, 980-CP or 981-CP, depending on arrangement desired. There are other arrangements available, which we have used on occasion, but these two work for almost every application we see. For curb or wall mount GAV valves, specify Chicago 986-CP flange

C. Vacuum and Pressure Switches

1. Switches shall incorporate UL listed single-pole, double-throw, and snap-action switching elements. Switch shall automatically reset.

2. Switches shall be housed in a watertight NEMA 4 enclosure with tamper-resistant external adjustment.

3. Signal setting for low vacuum shall be at 12” HG.

4. Signal settings for all pressure gases except Nitrogen shall be; Low – 40 psig, High – 60 psig.

5. Signal settings for Nitrogen gas shall be; Low – 140 psig, High – 190 psig.

D. Pressure switches shall be cleaned and sealed for oxygen service.

E. Natural gas piping only

1. The gas distribution system shall be installed as indicted on the Drawings, complete with all valves, regulators, meters and other required item.

2. Verify and coordinate, with actual various users on the site, all the times and timing involved with modifications, additions to, or alterations thereof, of gas piping serving these users

3. The natural gas system shall be installed using the materials and methods as specified herein and in the following paragraphs

a. Piping

1) All pipe used for the fabrication of gas piping system shall be schedule 40 black steel pipe and fittings. See section 23 21 10.

2) Unless otherwise specifically required, all steel pipe provided for gas piping systems shall be provided with plain ends and assembled with weld fittings on all pipe 1 ¼”. No pipe smaller than ¾”, except as detailed for laboratory furniture, shall be used. From emergency shutoff valve to the outlets the pipe shall be assembled with threaded fittings provided all joints are exposed or within the confines of the laboratory furniture.

3) All gas piping within the building shall be installed exposed to view.

4) Assemble threaded joints with Teflon tape rated for use with natural gas

5) All exposed natural gas piping shall be painted safety yellow

b. Headers

1) The gas distribution header installed by the Contractor in the building shall be fabricated of schedule 40 steel pipe. The pipe and welding material for this header shall be carefully selected, and the welding operations shall be carefully supervised.

2) Welding nipples neatly aligned shall be provided for the outlets of the header. After the header has been completely fabricated, it shall be temporarily sealed and subjected to a pneumatic pressure test of 100 pounds per square inch. While the header is subjected to this pressure, all welded joints shall be given an application of soapy water for the purpose of detecting minute leaks which might not otherwise be observed. These leaks shall not be repaired by any peening operations. Such leaks shall be remedied by the shipping and re-welding until the header is devoid of leaks at that pressure. The header shall then be subjected to a hydrostatic pressure test of 200 pounds per square inch. Under these circumstances, the test pressure of the water confined in the header shall not decrease in a four hour period of observation. If leaks are encountered, they shall be repaired and re-tested until proven tight.

3) The header shall be provided with a one-half inch (1/2") drain connection "taken off" the bottom of the header and terminated in a suitable stop cock. This one-half inch (1/2") drain connection shall have its origin in a 2" x ½" welding reducer having its two inch (2") end so welded to the header as to completely drain that member. Each outgoing branch from the header shall be provided with a gas stop valve of gas cock. The nature of the outgoing welding nipples shall be such that these cocks shall be aligned in a neat horizontal line.

c. Cocks

1) Near the point at which each outgoing line leaves the gas heater, the contractor shall install a gas stop valve or gas cock. These wrench operated valves shall each be provided with an appropriate wrench. Cocks of the same type shall, moreover, be installed at each other point indicated on the drawings.

2) Each separate laboratory shall have an emergency gas shut off valve (E650) controlling all natural gas in the lab, reference make and model of IC# 6205.

d. Drip pipes

1) Drip pipes shall be provided throughout the gas piping system for the purpose of accumulating moisture and condensate. They shall be sized no smaller than the gas piping to which they are connected in each instance. These drip pipes shall be U-shaped providing an effective water seal of no less than twelve inches (12") of water. The extremity of each U-shaped drip pipe shall be threaded and capped with a suitably sized, screwed pattern, black, standard weight, and malleable iron cap.

2) All drip pipes shall be located in an accessible position so that the condensate may either be pumped from the system or so that a water deal shall be provided in the event that the water forming the seal evaporates.

e. Fabrication methods

1) All interior gas piping shall, wherever possible, be installed so as to grade back toward the gas header in the basement. In all cases where such grading is impracticable and it is necessary to grade the house piping away from the inlet, drip pipes of adequate capacity must be installed where traps are formed by such changes in grade. Drip pipes shall terminate with a screwed pattern, malleable iron black cap. No drip pipes shall be used as outlets for the attachment of any fixture or gas appliance. Drip pipes must, moreover, be placed at the bottom of all vertical pipes which rise from and connect to the end of any horizontal pipe.

2) All house piping must be securely fastened in place in such a manner as to maintain its grading. Under no circumstances shall extension bars be used for supporting gas piping. Under no circumstances shall any gas piping be used to support any weight other than its own weight.

3) All branch outlet pipes shall be taken from the top or sides of running horizontal lines and not from the bottom. No crosses shall be installed in any horizontal gas line. No unions, gas cocks, or valves shall be used in any concealed location. Every gas cock and valve shall be accessible for inspection and repair.

4) The general arrangement of all gas piping shall be such that the number of threaded joints involved is reduced to an absolute minimum. If obstructions are encountered, pipe shall not be bent to circumvent such obstructions. Welding fittings shall be used for this purpose in the case of the welded lines, and it threaded lines are involved, screwed fittings shall be used. Wherever gas pipes run through outside brick, stone or other walls, the opening around the pipe shall be securely and rigidly sealed. Gas pipe sizes shall be at least one pipes size larger than the inlet of the gas appliance which they supply. No bushings shall be used in conjunction with any gas piping.

f. Testing

1) All gas piping systems shall be completely tested by the contractor. These piping systems shall first be subjected to a pneumatic test pressure per Section 20 01 00. All hydro and pneumatic tests shall be dead weighted, recorded, and countersigned by the project inspector. While the systems are subjected to this air pressure, all welded joints shall have a soapy water solution applied for the purpose of detecting minute as well as larger leaks, and shall be witnessed by Owner. A final test shall be performed after casework and lab hook up are competed at 15 psi for a minimum of 4 hours. If leaks are found, they shall be repaired until gas piping systems are absolutely tight at the pneumatic test pressure indicated above. If leaks occur in the case of threaded joints, such leaks shall be eliminated by legitimate means, i.e., either by replacing leaking fittings or my tightening them properly. Leaking flanged joints shall have flange bolts appropriately tightened or have gaskets causing leaks repaired.

2) The entire gas piping systems shall be re-subjected to a pneumatic test pressure per Section 20 01 00. Such gas piping systems must be demonstrated to be absolutely tight when subjected to this pressure for a period of twenty-four hours. In all instances in which leaks are then found, they shall be eliminated in ate manner designated by The University’s duly authorized representative. A one-half inch (1/2”) test connection and cap shall be provided in each branch of the gas piping system.

3) After all pneumatic testing of the entire gas piping system has been completed and all leaks have been repaired an d at a time deemed suitable by The University’s duly authorized representative, the contactor shall have the gas supply turned on and the gas odorant chemical added by a representative of a gas company. The contractor shall then bleed gas from every riser and every run out until the odor is present in the proper quantity at every gas outlet.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.:

C. Exercise great care in the storage and handling of all materials and in the condition of tools used in cutting and reaming to prevent oil or grease or any contaminants from being introduced into tubing. The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service by the manufacturer, but become contaminated prior to being installed, shall be recleaned on-Site by the installer by thoroughly scrubbing the interior surfaces with a clean, hot water–alkaline solution, such as sodium carbonate or trisodium phosphate 450 g to 11 L (1 lb. to 3 gal) of potable water and thoroughly rinsing them with clean, hot potable water. Material that has become contaminated internally and is not clean for oxygen service shall not be installed.

D. The exterior surface of all tubes, joints and fittings shall be cleaned prior to brazing with non-abrasive pads by washing with hot water after assembly to remove any surface oxides or excess flux and provide for clear visual inspection of brazed connections. A visual inspection of each brazed joint shall be made to assure that the alloy has flowed completely around the joint at the tube-fitting interface. Where flux has been used, assure that solidified flux residue has not formed a temporary seal that could hold test pressure.

E. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside of completed joints. (NOTE : Ensure proper ventilation. Some BAg series filler metals contain cadmium, which, when heated during brazing, can produce toxic fumes.)

F. Joints shall be brazed within one hour after the surfaces are cleaned for brazing.

G. While being brazed, all vacuum and oxygen piping joints shall be continuously purged with oil-free, dry Nitrogen to prevent the formation of copper oxide on the inside surfaces of the joint. The purge shall be maintained until the joint is cool to the touch. The final connection of new piping to an existing, in-use pipeline shall be permitted to be made without the use of a nitrogen purge.

H. Bury all underground piping at least 3 feet below finished grade and fully encase within schedule 40 PVC piping sleeve. Provide a continuous detectable warning tape immediately above buried lines. Warning tape shall clearly identify the pipeline by specific name. A continuous warning means shall also be provided on tamped backfill above the pipeline at approximately one-half the depth of bury.

I. Do not install piping in the same trench with other buried utilities. The minimum horizontal clearance between laboratory pipe and parallel buried utility pipe shall be 8 feet. Do not install pipe through catch basins, vaults, manholes or similar underground structures.

J. Piping shall not be installed in kitchens, electrical switchgear rooms, elevator shafts, and areas with open flames.

K. Memory-metal couplings shall not be installed within eight inches of a brazed joint.

L. Shut-off valves installed for future connections shall be provided with downstream piping closed with a brazed cap and sufficient tubing allowance for cutting and re-brazing.

M. Branch takeoffs from horizontal piping shall be taken off above the centerline of the main or branch pipe and rise vertically or at an angle of not less than 45 degrees from vertical.

N. Support all piping in accordance with NFPA 99 and Specification Section 15140.

O. Pressure and vacuum indicators shall be readable from a standing position.

P. Zone valve boxes shall be installed where they are visible and accessible at all time and readily operable from a standing position in the corridor on the same floor they serve.

Q. Area alarm panels shall be located where indicated on Contract Drawings at a nurse’s station or other location that will provide for continuous responsible surveillance.

R. Locate master alarm panels shall where indicated on Contract Drawings in at least two separate locations as required by NFPA 99.

S. All alarm panels shall be mounted at a height allowing monitoring and operation from a standing position.

3.02 LABELING

A. Label all piping, valves, station inlets and outlets, and alarms in accordance with NFPA 99 requirements and Contract Documents.

B. Re-label existing shut-off valves and alarm panels when modifications are made changing the areas served. New labels shall be in accordance with NFPA 99 and Contract Documents.

3.03 TESTING AND INSPECTION

A. Inspection and testing shall be performed on all new piped gas systems, additions, renovations, temporary installations, or repaired systems, to assure the facility, by a documented procedure, that all applicable provisions of NFPA 99 have been adhered to and system integrity has been achieved or maintained.

B. After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and permit clear visual inspection of the joint. Each brazed joint shall be visually inspected after cleaning the outside surfaces. Brazed joints identified as defective shall be repaired or replaced as required by NFPA 99.

C. After installation of the distribution piping and before installation of station outlets/inlets and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators), piping in laboratory vacuum and gas distribution systems shall be blown clear by means of oil-free, dry Nitrogen.

D. Installer shall perform initial pressure tests, cross-connection test, piping purge test and standing pressure test prior to third party system verification and in strict accordance with NFPA 99.

E. System verification tests shall be performed only after all installer performed tests, have been completed. Equipment Vendor or installing Contractor shall not perform system verification, final testing or certification.

F. A Third Party Medical Gas System Verification Testing Agency shall perform standing pressure test, cross-connection test, valve test, alarm test, piping purge test, piping particulate test, piping purity test, final tie-in test, operational pressure test and gas concentration test.

G. The Third Party Medical Gas System Verification Testing Agency shall verify the presence and correctness of labeling required by this standard for all components (e.g., station outlets/inlets, shutoff valves, and alarm panels).

H. It shall be the responsibility of the Third Party Medical Gas System Verification Testing Agency to make periodic job Site visits to assure all requirements of this specification and NFPA 99 are strictly adhered to.

I. Certification shall clearly state that the system is approved for use and meets all requirements of NFPA-99 inclusive of all referenced and/or related documents. Any exceptions or limitations shall be clearly stated on the same certification document.

3.04 VENDOR SUPERVISION AND OPERATING INSTRUCTIONS

A. An authorized representative of the equipment manufacturer shall periodically check with the installing Contractor during initial installation of the pipeline systems and equipment and shall assist the Contractor in final check to make certain that all systems are operating as recommended by the manufacturer, as specified and in accordance with NFPA 99. The equipment manufacturer's representative shall provide a minimum of 4 hours instruction to M. D. Anderson Cancer Center personnel in the use of the piping systems and the related equipment operated from those systems.

END OF SECTION 22 11 19 00

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SECTION 22 11 19 00A - LABORATORY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Provide materials and installation for complete first class systems, within and to five feet beyond building perimeter unless noted otherwise on Contract Drawings; pipe, fittings, supports, testing and other normal parts that make the systems operable, code compliant and acceptable to the authorities having jurisdiction.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. 2015 Edition of the International Plumbing Code.

1.04 QUALITY ASSURANCE

A. All above ground pipe and fittings of same material shall be product of one manufacturer.

B. All buried pipe and fittings of same material shall be product of one manufacturer

C. All materials shall be new and undamaged.

D. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this Section.

E. Installer Qualifications: Company shall have minimum three years documented experience specializing in performing the Work and installing the types of materials specified within this Section. Installation of drainage and vent systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

1.05 SUBMITTALS

A. Product Data:

1. Provide Code and Standards compliance, manufacturer's data for pipe, fittings, couplings, gaskets and all other products included within this Specification Section.

B. Record Documents:

1. Submit test reports and inspection certification for all systems listed herein.

2. Provide full written description of manufacturer’s warranty.

3. Record actual locations and sizes of piping.

4. Manufacturer’s Installation Instructions.

C. Operation and Maintenance Data:

1. Include components of system, Record Documents, inspection data, installation instructions, exploded coupling assembly views, replacement part numbers and availability, location and contact numbers of supply depot.

1.06 DELIVERY, STORAGE AND HANDLING

A. Accept products on Site in shipping containers and maintain in place until installation.

B. Provide temporary protection for materials not packaged within containers. Maintain in place until installation.

C. Provide temporary end caps and closures on pipe and fittings. Maintain in place until installation.

D. Protect installed piping and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, paint spray, etc. Remove all foreign materials and clean materials as Work progresses.

E. Protect all materials that are to be installed within this project from exposure to rain, freezing temperatures and direct sunlight.

F. Protect Sealite rope packing prior to installation within packaging to maintain a moisture content of 8-10%.

1.07 EXTRA MATERIALS

A. Furnish to Owner pipe grooving tools after completion of the job. Tools shall be of same manufacturer as pipe and capable of grooving all sizes of thermoplastic piping installed.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 PIPE AND FITTINGS

A. Above ground pipe and fittings not located within spaces utilized as air plenums shall be manufactured from NSF listed Type 1, flame retardant Schedule 40 polypropylene conforming to ASTM D4101, with a maximum average flame spread of zero seconds and a maximum extent of burning of 13 mm, in accordance with ASTM D635. Matched fittings shall be manufactured from NSF listed flame retardant polypropylene with average maximum burn time of 80 seconds and maximum extent of burning of 20 mm in accordance with ASTM D635. Fittings shall be designed to lock into a machined groove on the mating piping. All fittings shall have integrally molded union connections. No metallic grab rings or clamps shall be allowed. Fittings containing EVA (ethylene vinyl acetate) are strictly prohibited. Couplings shall not be added to make mechanical joint fittings.

B. Polypropylene pipe and fittings shall be as manufactured by IPEX, “Labline”, or approved equivalent. Connections between polypropylene pipe and matched fittings shall be made using the “Labline” Joint.

C. Above ground pipe and fittings located within spaces utilized as air plenums shall be IAPMO listed, Schedule 40, FR-PVDF manufactured from Kynar 740-02, flame retardant Polyvinylidene Fluoride (PVDF) conforming to ASTM F 1673, with a limiting oxygen index (LOI) of 60, Resin must have a vertical burn rating of 94 V-0. Kynar 740-02 resin based on testing to ASTM E84 (UL 723) must have surface burning characteristics greater than or equal to a flame spread 5 and smoke development 35. Fittings shall be third party certified to ASTM F 1673 and ASTM E84, and IAPMO approved, with a tapered elastic retaining ring designed to lock into a machined groove on the mating piping. All fittings shall have integrally molded union connections. No metallic grab rings or clamps shall be allowed.

D. Polyvinylidene Fluoride pipe and fittings shall be as manufactured by IPEX, “Plenumline”, or approved equivalent.

E. Polypropylene traps under sinks shall be two-piece p-traps, Labline Number W1021 or approved equal. Polypropylene traps for cup sinks and for special areas that may contain a high content of solids in waste shall be universal type trap, Labline Number W501 or approved equal.

F. All buried pipe and fittings shall be bell & spigot, extra heavy weight, high silicon iron pipe and fittings conforming to the most recent revision of ASTM Specifications A518 and A861, as manufactured under the trade name of “Duriron” by the Flowserve Corporation. Joints shall be made utilizing virgin lead and Red Stripe Sealite A312 acid-resistant rope packing. Hemp, oakum, nor dry asbestos packing will be acceptable.

G. Make connections and provide adapters and transition fittings recommended by piping manufacturer where connecting to fixtures and dissimilar piping.

2.03 FLOOR DRAINS

A. Floor drains shall be high silicon content corrosion-resistant cast iron, with sediment basin, flashing ring, grate and inside caulk connection, as manufactured under the trade name of “Duriron” by the Flowserve Corporation, model D5501BBF or approved equal.\

2.04 CLEANOUTS

A. Cleanout ferrules and plugs shall be of the same material or have chemical resistance equal to or greater than the piping material.

B. Cleanouts shall be provided with stainless steel access covers of adequate size to allow rodding of system. Cleanouts incorporating cover screws that extend completely through access plugs are not acceptable.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry and not over-excavated. Do not install underground piping when bedding is wet or frozen.

B. Before commencing Work, check final grade and pipe invert elevations required for drain terminations and connections to ensure proper slope.

C. Do not use excessively wet or frozen Sealite rope packing within hub and spigot joints. Sealite rope packing shall be soft and pliable when installed.

3.02 PREPARATION

A. Remove foreign material, burrs, scale and dirt from inside and outside of piping, before assembly.

3.03 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. General

1. Install all materials and products in accordance with manufacturer’s published recommendations. Use tools manufactured for the installation of the specific material or product.

2. All excavation required for plumbing Work is the responsibility of the Plumbing Contractor and shall be done in accordance with Contract Specifications.

3. Trenches shall be excavated so as to provide adequate room to make joints, align, and properly grade the pipe. The trench bottom shall be properly compacted and rock-free and shall support the pipe throughout its entire length. Fill material shall be applied in layers not exceeding 6 inches loose depth and each layer shall be thoroughly compacted. The first 6 inches of fill material shall be rock-free.

4. Buried piping shall be supported throughout its entire length.

5. Bury outside drainage pipe minimum one foot below recorded frost depth.

6. Pipe, fittings and couplings shall not directly contact or be encased in concrete. Pipe joints shall not be located within wall, floor or roof penetrations.

7. All piping shall be isolated from building structures, including partition studs, to prevent pipe damage and transmission of vibration and noise.

8. Route piping in direct orderly manner and maintain proper grades. Installation shall conserve headroom and interfere as little as possible with use of spaces. Route exposed piping parallel to walls.

9. Install piping to allow for expansion and Contraction without stressing pipe or joints and as recommended by the piping manufacturer.

10. Furnish all supports required by the piping included in this Specification Section.

11. Penetrations through fire rated walls, floors and partitions shall be sealed to provide a U.L. rating equal to or greater than the wall, floor or partition.

12. Seal all penetrations through exterior building walls and grade beams air and watertight.

13. Furnish and install all necessary traps, adapters, etc. for each fixture having laboratory waste connections, to facilitate proper functioning, servicing and compliance with code.

14. Provide code-approved transition adapters when joining dissimilar piping materials. Adaptors installed shall be manufactured specifically for the particular transition. Molten lead shall not be used to join thermoplastic piping to Duriron pipe hubs or floor drains.

15. Insulated all above ground floor drain bodies, p-traps and horizontal waste piping from drain to vertical stack that receives cold (60 degree F. or below) drainage to prevent condensation in accordance with Contract Documents.

16. Provide clearance for installation of insulation.

17. Slope drainage lines uniformly at 1/4" per foot, for lines 3" and less, and 1/8" per foot for larger lines, unless noted otherwise on Drawings. Slope vent piping uniformly to drain. Maintain gradients through each joint of pipe and throughout system.

18. The size of drainage piping shall not be reduced in size in the direction of flow. Drainage and vent piping shall conform to the sizes indicated on the Contract Drawings. Under no circumstances shall any drain or vent line below slab be smaller than two inches.

19. Unburied horizontal piping shall be supported at maximum intervals of four feet on piping sizes 4” and larger, and three feet on piping sizes 2” and smaller and at least at every other joint. Supports shall also be provided at each horizontal branch connection and at the base of each vertical rise. Supports shall be placed immediately adjacent to the joint. Suspended lines shall be braced to prevent horizontal movement. Unburied vertical piping rising through more than one floor level shall be supported with padded riser clamps at each floor level.

20. Supports shall not clasp the pipe so tightly as to prevent normal lateral movement due to expansion.

21. Horizontal supports shall provide a wide bearing area and be free of burrs or sharp edges.

22. Provide cleanouts within waste systems at locations and with clearances as required by the International Plumbing Code, at the base of each waste stack and at intervals not exceeding 90 feet in horizontal runs.

23. All interior cleanouts shall be accessible from walls or floors. Provide wall cleanouts in lieu of floor cleanouts wherever possible. A floor cleanout shall be installed only where installation of a wall cleanout is not practical.

24. Coordinate the location of all cleanouts with the architectural features of the building and obtain approval of locations from the Project Architect.

25. A removable sink p-trap with cleanout plug shall be considered as an approved cleanout for 2” diameter pipe.

26. Cleanout plugs shall provide a water and gas tight seal.

27. Install trap primer supply to floor drains and hub drains that are susceptible to trap seal evaporation and where indicated on Project Drawings. Primer unit installation shall comply with manufacturer's published recommendations. Trap primer lines shall slope to drain at a minimum ¼” per foot.

28. Capped waste and vent connections for future extensions shall be located accessibly and not extend more than 24” from active main. Waste connections and vent connections shall be located at elevations that will allow future installation of properly sloped piping without the need to dismantle or relocate installed ductwork, piping, conduit, light fixtures, etc.

29. Each plumbing pipe projecting through roof shall be installed in accordance with Contract Specifications and Drawings. Penetrations shall be sealed air and water tight. Refer to details on Contract Drawings and coordinate with General Contractor for flashing requirements.

30. Unless indicated otherwise within Contract Documents, all vent pipes passing through the roof shall be provided with lead roof flashings constructed of 2-1/2 pound sheet lead with bases extending no less than ten inches on each side of the pipe. The vertical portion of the flashing shall extend upward the entire length of pipe and be turned tightly inside the pipe at least two inches and shall not reduce the inside diameter of vent pipe more than the thickness of the flashing. Lead flashings shall be furnished by Plumbing Contractor and turned over to Roofing Contractor for installation.

31. Locate all laboratory vent terminals a minimum of 25 feet horizontally from or 3 feet vertically above all air intakes, operable windows, doors and any other building openings.

3.04 TESTING

A. General

1. Equipment, material, power, and labor necessary for the cleaning, flushing, inspection and testing of systems covered within this Specification Section shall be furnished by the Plumbing Contractor. All testing and inspection procedures shall be in accordance with Division 1 and Special Condition requirements of this Contract.

2. Prior to testing fill hub and spigot pipe and fittings with water and waiting 24 hours to allow the Sealite rope packing to absorb the fluid and sufficiently expand to seal the joint.

3. Prepare testing reports. If testing is performed in segments, submit separate report for each segment, complete with diagram or clear description of applicable portion of piping. After inspection has been approved or portions thereof, certify in writing the time, date, name and title of the persons reviewing the test. This shall also include the description of what portion of the system has been approved. Obtain approval signature by Owner’s Representative. A complete record shall be maintained of all testing that has been approved, and shall be made available at the job Site. Upon completion of the Work, all records and certifications approving testing requirements shall be submitted to The University’s Representative before final payment is made.

4. Verify systems are complete, flushed and clean prior to testing. Isolate all fixtures subject to damage from test pressure. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. Leave piping uncovered and unconcealed until it has been tested and approved. Expose Work that was covered or concealed before it was tested.

5. Testing with compressed air is prohibited.

6. Separately test above and below ground piping. Do not introduce water into piping systems when exposure to freezing temperatures is possible.

7. Defective Work or material shall be reworked and replaced, and inspection and test repeated. Repairs shall be made with new materials. Pipe dope, caulking, tape, dresser couplings, etc., shall not be used to correct deficiencies.

8. The Contractor shall be responsible for cleaning up any leakage during flushing, testing, repairing and disinfecting to the original condition any building parts subjected to spills or leakage.

9. Subject all piping and joints to a vertical water column pressure of at least ten feet. EXCEPTION: Portions of drainage and vent piping located on uppermost level of building shall be subjected to a water column pressure created by filling the system to point of overflow at roof vent terminals and roof drains. The pipes for the level being tested shall be filled with water to a verifiable and visible level as described above and be allowed to remain so for 12 hours. If after 12 hours the level of the water has been lowered by leakage, the leaks must be found and stopped, and the water level shall again be raised to the level described and the test repeated until, after a 12 hour retention period, there shall be no perceptible lowering of the water level in the system being tested.

10. Should the completion of these tests leave any reasonable question of a doubt relative to the integrity of the installation, additional tests or measures shall be performed to demonstrate the reliability of these systems to the complete satisfaction of The University's Representative.

11. Test plugs must extend outside the end of pipe to provide a visible indication for removal after the test has been completed.

END OF SECTION 22 11 19 00A

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SECTION 22 43 39 00 - MEDICAL PLUMBING FIXTURES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for medical plumbing fixtures. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.02 SUMMARY

A. This Section includes the following medical plumbing fixtures and related components:

   1. Faucets for lavatories, showers, and sinks.
   2. Laminar-flow, faucet-spout outlets.
   3. Flushometers.
   4. Toilet seats.
   5. Protective shielding guards.
   6. Fixture supports.
   7. Bedpan washers.
   8. Water closets.
   9. Lavatories.
   10. Individual showers.
   11. Patients' combination toilets.
   12. Clinical sinks.
   13. Plaster sinks.
   14. Surgeons' scrub sinks.
   15. Surgeons' instrument sinks.
   16. Bathing units.
   17. Sitz baths.
   18. Bedpan washing equipment.
   19. Hydrotherapy whirlpools.
   20. Outlet boxes.
   21. Morgue equipment.

1.03 DEFINITIONS

A. Accessible Medical Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

1.04 SUBMITTALS

A. Product Data: For each type of medical plumbing fixture indicated.

B. LEED Submittal:

1. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Operation and maintenance data.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act", **as directed**; for plumbing fixtures for people with disabilities.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

2. Plastic Bathtubs: ANSI Z124.1.

3. Plastic Shower Enclosures: ANSI Z124.2.

4. Slip-Resistant Bathing Surfaces: ASTM F 462.

5. Vitreous-China Fixtures: ASME A112.19.2M.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
2. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
3. Faucets: ASME A112.18.1.
4. Hose-Connection Vacuum Breakers: ASSE 1011.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
7. NSF Materials: NSF 61.
8. Pipe Threads: ASME B1.20.1.
9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
10. Supply Fittings: ASME A112.18.1.
11. Brass Waste Fittings: ASME A112.18.2.

H. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Flexible Water Connectors: ASME A112.18.6.
4. Manual-Operation Flushometers: ASSE 1037.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
6. Brass Waste Fittings: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Grab Bars: ASTM F 446.
2. Hose-Coupling Threads: ASME B1.20.7.
3. Off-Floor Fixture Supports: ASME A112.6.1M.
4. Pipe Threads: ASME B1.20.1.
5. Plastic Toilet Seats: ANSI Z124.5.
6. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.01 LAVATORY FAUCETS

A. Description: Faucet for lavatory-type medical plumbing fixture. Coordinate faucet inlets with supplies, connectors, and fixture holes; coordinate outlet with spout and fixture receptor.

1. Maximum Flow Rate: 2.2 gpm (8.3 L/min.).
2. Body Material: Solid brass.
3. Finish: Polished chrome plate.
4. Type: Single-control mixing **OR** Single-valve nonmixing **OR** Two-handle mixing, **as directed**.
5. Tempering System: Not required **OR** Thermostatic **OR** Pressure balance, **as directed**.
6. Supply Centers: Single hole **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** Adjustable, **as directed**.
7. Mounting: Deck, exposed **OR** Deck, concealed **OR** Back/wall, exposed **OR** Back/wall, concealed, **as directed**.
8. Handle(s): Single lever **OR** Cross, four arm **OR** Wrist blade, 4 inches (102 mm) **OR** Elbow, 6 inches (152 mm) **OR** Not applicable, **as directed**.
9. Temperature Indicators: Color-coded for hot and cold water.
10. Inlet(s): NPS 3/8 (DN 10) tubing, plain end **OR** NPS 3/8 (DN 10) tubing, with NPS 1/2 (DN 15) male adaptor **OR** NPS 1/2 (DN 15) male shank **OR** NPS 1/2 (DN 15) female shank, **as directed**.
11. Spout: Rigid **OR** Swing **OR** Rigid gooseneck **OR** Swivel gooseneck, **as directed**, brass.
12. Spout Outlet: Aerator **OR** Spray **OR** Laminar flow **OR** Plain end **OR** Spray, 0.5 gpm (1.5 L/min.), **as directed**.
13. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.
14. Drain: Pop up **OR** See fixture, **as directed**.

2.02 SHOWER FAUCETS

A. Description: Faucet for shower-type medical plumbing fixtures. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies.

1. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.

2. Body Material: Solid brass.

3. Finish: Polished chrome plate.

4. Type: Thermostatic **OR** Pressure balance **OR** Thermostatic and pressure balance, **as directed**, with integral or field-installed check stops on hot- and cold-water supplies.

5. Mounting: Exposed **OR** Concealed, **as directed**.

6. Handle(s): Single lever **OR** Cross, four arm **OR** Not applicable, **as directed**.

7. Temperature Indicators: Color-coded for hot and cold water.

8. Diverter Valve: Not required **OR** Integral with mixing valve **OR** Not integral with mixing valve, **as directed**.

9. Backflow Protection Device for Hand-Held Shower: Required **OR** Not required, **as directed**.

10. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.

11. Antiscald Device: Integral with mixing valve **OR** Not required, **as directed**.

12. Supply Connections: NPS 1/2 (DN 15) **OR** NPS 1/2 (DN 15), union **OR** Sweat, **as directed**.

13. Shower Head Material: Brass with chrome-plated finish.

14. Head Type: Ball joint **OR** Without ball joint **OR** Hand held, slide-bar mounted, **OR** Hand held, hook mounted, **as directed**.

15. Spray Pattern: Fixed **OR** Adjustable, **as directed**.

16. Integral Volume Control: Required **OR** Not required, **as directed**.

17. Shower-Arm, Flow-Control Fitting: Not required **OR** 1.5 gpm (5.7 L/min.) **OR** 2.0 gpm (7.6 L/min.), **as directed**.

2.03 SINK FAUCETS

A. Description: Faucet for sink-type medical plumbing fixtures. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

1. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.

2. Body Material: Solid brass.

3. Finish: Polished chrome plate **OR** Rough chrome plate, **as directed**.

4. Type: Sink faucet **OR** Clinical-sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook, **as directed**.

5. Tempering Device: Thermostatic **OR** Pressure balance **OR** Not required, **as directed**.

6. Mixing Valve: Single control **OR** Two-lever handle, **as directed**.

7. Backflow Protection Device for Hose Outlet: Required **OR** Not required **OR** Not applicable, **as directed**.

8. Supply Centers: Single hole **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** Adjustable, **as directed**.

9. Mounting: Deck, exposed **OR** Deck, concealed **OR** Back/wall, exposed **OR** Back/wall, concealed, **as directed**.

10. Handle(s): Lever **OR** Knob **OR** Cross, four arm **OR** Wrist blade, 4 inches (102 mm) **OR** Elbow, 6 inches (152 mm) **OR** Not applicable, **as directed**.

11. Temperature Indicators: Color-coded for hot water on left and cold water on right.

12. Inlet(s): NPS 3/8 (DN 10) plain-end tubing **OR** NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter **OR** NPS 1/2 (DN 15) male shank **OR** NPS 1/2 (DN 15) female shank, **as directed**.

13. Spout: Rigid, solid **OR** Swing tubular **OR** Rigid, gooseneck, solid **OR** Swivel, gooseneck, solid, **as directed**, brass with wall brace, **as directed**.

14. Spout Outlet: Aerator **OR** Swivel aerator/spray **OR** Spray **OR** Laminar flow **OR** Hose thread **OR** Plain end, **as directed**.

15. Vacuum Breaker: Required **OR** Not required, **as directed**.

16. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.

2.04 LAMINAR-FLOW FAUCET-SPOUT OUTLETS

A. Description: Chrome-plated-brass faucet-spout outlet that produces non-aerating laminar stream. Include male or female thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.05 FLUSHOMETERS

A. Description: Flushometer for clinical-sink-type **OR** water-closet-type, **as directed**, medical plumbing fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, **as directed**, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.

1. Internal Design: Diaphragm operation.

2. Style: Exposed **OR** Concealed, **as directed**.

3. Inlet Size: NPS 1 (DN 25).

4. Trip Mechanism: Oscillating, lever-handle actuator **OR** Mechanical, push-button actuator with stainless-steel access plate **OR** Hydraulic, push-button actuator **OR** Foot-pedal actuator **OR** Hard-wired, electric-sensor actuator **OR** Battery-operated sensor actuator, **as directed**.

5. Consumption: 1.6 gal./flush (6.0 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.

6. Tailpiece Size: NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, and standard length to top of bowl.

7. Integral Bedpan Washer: Not required **OR** Factory fabricated, attached to tailpiece, and with spray head, **as directed**.

2.06 TOILET SEATS

A. Description: Plastic toilet seat for water-closet-type medical plumbing fixture.

1. Material: Molded, solid plastic with antimicrobial agent, **as directed**.
2. Configuration: Closed **OR** Open, **as directed**, front with **OR** without, **as directed**, cover.
3. Size: Elongated, unless otherwise indicated.
4. Class: Standard **OR** Heavy-duty, **as directed**, commercial.
5. Hinge Type: Stainless-steel CK, check **OR** SC, self-sustaining check, **as directed**.
6. Color: White **OR** Black, **as directed**.

2.07 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Description: Manufactured plastic wraps for covering medical plumbing fixture hot-water supply **OR** hot- and cold-water supplies, **as directed**, and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Description: Manufactured plastic enclosure for covering medical plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.08 FIXTURE SUPPORTS

A. Water-Closet Supports:

1. Description: Combination carrier designed for accessible **OR** standard, **as directed**, mounting height of wall-mounting, water-closet-type medical plumbing fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

B. Lavatory Supports:

1. Description: Type I, lavatory carrier with exposed arms and tie rods **OR** Type II, lavatory carrier with concealed arms and tie rod **OR** Type III, lavatory carrier with hanger plate and tie rod, **as directed**, for wall-mounting, lavatory-type medical plumbing fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

C. Sink Supports:

1. Description: Type I, sink carrier with exposed arms and tie rods **OR** Type II, sink carrier with hanger plate, bearing studs, and tie rod **OR** Type III, sink carrier with hanger plate and exposed arms, **as directed**, for sink-type medical plumbing fixture. Include steel uprights with feet.

D. Bedpan Washers

1. Description: Wall-mounting, hand-held, hand-control **OR** single-pedal, foot-control **OR** double-pedal, hot- and cold-water control, **as directed**, medical plumbing fixture.
   a. Hose: 48-inch- (1220-mm-) long rubber or vinyl hose with spray nozzle, wall bracket, and hook.
   b. Self-closing valve.

c. Loose-key supply stop.

d. Vacuum Breaker: Wall mounting, atmospheric.

e. Finish: Polished, chrome-plated finish on metal parts exposed after installation.

2.09 WATER CLOSETS

A. Wall-Mounting Water Closets:

1. Description: Accessible, wall-mounting **OR** Wall-mounting, **as directed**, back-outlet, vitreous-china medical plumbing fixture designed for bedpan washing and flushometer valve operation.

a. Style: Flushometer valve.

1) Bowl Type: Elongated with siphon-jet design and bedpan lugs or slots.

2) Design Consumption: 1.6 gal./flush (6 L/flush).

3) Color: White.

B. Floor-Mounting Water Closets:

1. Description: Accessible, floor-mounting **OR** Floor-mounting, **as directed**, floor-outlet, vitreous-china medical plumbing fixture designed for bedpan washing and flushometer valve operation.

a. Style: Flushometer valve.

1) Bowl Type: Elongated with siphon-jet design and bedpan lugs or slots. Include bolt caps matching fixture.

2) Height: Standard **OR** Accessible, **as directed**.

3) Design Consumption: 1.6 gal./flush (6 L/flush).

4) Color: White.

2.10 LAVATORIES

A. Wall-Mounting Lavatories:

1. Description: Accessible, wall-mounting **OR** Wall-mounting, **as directed**, vitreous-china medical plumbing fixture.

a. Type: With back **OR** Ledge back **OR** Shelf back **OR** Slab, **as directed**.

b. Size: 18 by 15 inches (457 by 381 mm) **OR** 19 by 16 inches (483 by 406 mm) **OR** 20 by 18 inches (508 by 457 mm) **OR** 24 by 20 inches (610 by 508 mm), **as directed**, rectangular.

c. Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.

d. Faucet Hole Location: Top **OR** Front wall **OR** Inclined panel, **as directed**.

e. Color: White.

f. Faucet: Lavatory with pop-up waste **OR** for separate drain, **as directed**.

g. Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.

h. Drain: See faucet **OR** Grid **OR** Grid with offset, **as directed**.

1) Location: Not applicable.

i. Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.

j. Protective Shielding Guard(s): Designation, as approved by The University.

k. Fixture Support: Lavatory.

B. Counter-Mounting Lavatories:

1. Description: Accessible, **as directed**, Counter-mounting **OR** Undercounter-mounting, **as directed**, vitreous-china, medical plumbing fixture.

a. Type: Flat rim with ledge **OR** Self-rimming, **as directed**.

b. Rectangular Lavatory Size: 18 by 15 inches (457 by 381 mm) **OR** 19 by 16 inches (483 by 406 mm) **OR** 20 by 18 inches (508 by 457 mm) **OR** 24 by 20 inches (610 by 508 mm), **as directed**.

c. Oval Lavatory Size: 19 by 16 inches (483 by 406 mm) **OR** 20 by 17 inches (508 by 432 mm), **as directed**.

d. Round Lavatory Size: 18 inches (457 mm) **OR** 19 inches (483 mm), **as directed**, in diameter.

e. Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.

f. Faucet Hole Location: Top **OR** Front wall **OR** Inclined panel, **as directed**.

g. Color: White.

h. Faucet: Lavatory with pop-up waste **OR** for separate drain, **as directed**.

i. Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.

j. Drain: See faucet **OR** Grid **OR** Grid with offset, **as directed**.

1) Location: Not applicable.

k. Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.

l. Protective Shielding Guard(s): Designation, as approved by The University.

2.11 INDIVIDUAL SHOWERS

A. Description: Accessible, **as directed**, FRP **OR** PMMA, **as directed**, shower enclosure medical plumbing fixture with slip-resistant bathing surface complying with ASTM F 462. Comply with ADA requirements for use by people with disabilities.

1. Size: 36 by 34 inches (915 by 865 mm) **OR** 42 by 36 inches (1065 by 915 mm) **OR** 43 by 39 inches (1090 by 990 mm) **OR** 48 by 34 inches (1220 by 865 mm) **OR** 52 by 36 inches (1320 by 915 mm) **OR** 60 by 36 inches (1525 by 915 mm) **OR** 72 by 36 inches (1830 by 915 mm), **as directed**.
2. Surround: One piece.
3. Color: White.
4. Faucet: Shower.
5. Drain: Grid, NPS 2 (DN 50).
    a. Location: Left side **OR** Center **OR** Right side, **as directed**.
6. Accessories: If not furnished as integral components of specified fixture. Accessories are specified in Division 10 Section "Toilet, Bath, And Laundry Accessories".
    a. Grab bar(s).
    b. Normal-duty **OR** Heavy-duty, **as directed**, shower-curtain rod.
    c. Vinyl **OR** Duck **OR** Antibacterial, **as directed**, shower curtain.
    d. Shower-curtain hooks.
    e. Folding seat, **as directed**.

2.12 PATIENTS' COMBINATION TOILETS

A. Swing-Away, Patients' Combination Toilets:

1. Description: Factory-fabricated, combination water closet and lavatory medical plumbing fixture.
    a. Cabinet: Fixed installation with storage space and toilet paper holder.
        1) Material: Stainless steel **OR** Stainless steel, plastic laminate, or fiberglass, **as directed**, with laminated-wood or -plastic **OR** solid-plastic **OR** stainless-steel, **as directed**, top surface.
        2) Color: Not applicable.
        3) Mounting: Wall bracket.
    b. Water Closet: Swivel, floor-mounting, back-outlet **OR** floor-outlet, **as directed**, flushometer valve design.
        1) Material: Stainless steel.
        2) Orientation: Left **OR** Right, **as directed**, hand.
        3) Color: Not applicable.
        4) Toilet Seat: White, solid plastic.

5) Flushometer: Concealed flushometer valve with push-button trip mechanism, check stop, and vacuum breaker on tailpiece.

6) Fixture Support: Floor plate.

7) Seal: For outlet.

c. Lavatory: Counter mounting.

1) Material: Stainless steel.

2) Color: Not applicable.

3) Faucet: Gooseneck type with wrist-blade handles **OR** Swing-spout type with single lever, **as directed**.

4) Drain: Grid, NPS 1-1/4 (DN 32).

5) Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.

d. Bedpan Washer: On flushometer valve tailpiece or separate attachment affixed to unit.

B. Static, Patients' Combination Toilets:

1. Description: Factory-fabricated, combination water closet and lavatory fixture.

a. Cabinet: Fixed installation; swing-away cabinet or retractable, water-closet cover design with storage space and toilet paper holder.

1) Material: Stainless steel **OR** Stainless steel, plastic laminate, or fiberglass, **as directed**, with laminated-wood or -plastic **OR** solid-plastic **OR** stainless-steel, **as directed**, top surface.

2) Color: Not applicable.

3) Mounting: Wall bracket.

b. Water Closet: Floor-mounting, floor-outlet, flushometer valve design.

1) Material: Stainless steel or vitreous china.

2) Orientation: Left **OR** Right, **as directed**, hand.

3) Color: Not applicable.

4) Toilet Seat: White, solid plastic.

5) Flushometer: Concealed flushometer valve with push-button trip mechanism, check stop, and vacuum breaker on tailpiece.

6) Seal: For outlet.

c. Lavatory: Counter mounting.

1) Material: Stainless steel.

2) Color: Not applicable.

3) Faucet: Gooseneck type with wrist-blade handles **OR** Swing-spout type with single lever, **as directed**.

4) Drain: Grid, NPS 1-1/4 (DN 32).

5) Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.

d. Bedpan Washer: On flushometer valve tailpiece or separate attachment affixed to unit.

2.13 CLINICAL SINKS

A. Wall-Mounting Clinical Sinks:

1. Description: Wall-mounting, back-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture.

a. Size: Approximately 25 by 20 inches (635 by 510 mm).

b. Color: White.

c. Rim Guard: Stainless steel on front and also on sides if flat rim.

d. Faucet: Sink, polished, chrome-plated, solid-brass, service-sink faucet type, including integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook.

B. Floor-Mounting Clinical Sinks:

1. Description: Floor-mounting, bottom-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture. Include bolt caps.

a. Size: Approximately 27 by 20 inches (685 by 510 mm).

b. Color: White.

c. Rim Guards: Stainless steel on front and sides.

d. Sink Base: 10-inch (25.4-mm) -high, cast terrazzo if required.

e. Faucet: Sink, polished, chrome-plated, solid-brass, service-sink faucet type, including integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook.

2.14 PLASTER SINKS

A. Description: Wall-mounting, vitreous-china medical plumbing fixture.

1. Size: 24 by 22 inches (610 by 560 mm) **OR** 30 by 22 inches (760 by 560 mm), **as directed**, with back or ledge faucet holes.

2. Color: White.

3. Faucet Holes: One **OR** Two, **as directed**, in back or ledge.

4. Faucet: Sink.

5. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.

6. Drain: Grid, NPS 1-1/2 (DN 40) with NPS 1-1/2 (DN 40) to NPS 2 (DN 50) adaptor, **as directed**.

7. Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, chrome-plated brass; 0.045-inch- (1.1-mm-) thick waste to interceptor; interceptor to wall; and wall flange.

8. Plaster Interceptor:

    a. Description: Cast-iron or steel body and removable cover with acid-resistant-enameled interior lining and outside coating; removable, corrosion-resistant metal screens or strainer; and NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, inlet and outlet.

B. Fixture Support: Sink with white-enameled-steel brackets.

2.15 SURGEONS' SCRUB SINKS

A. Stainless-Steel Surgeons' Scrub Sinks:

1. Description: Wall-mounting, sink-type medical plumbing fixture.

    a. Size: Approximately 31 by 20 inches (790 by 510 mm) with back with 1 faucet hole.

    b. Faucet: Chrome-plated-brass, gooseneck type matching fixture.

    c. Operation: Foot-pedal **OR** Knee **OR** Automatic, hard-wired electric sensor, **as directed**, control.

    d. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.

    e. Drain: Grid, NPS 1-1/2 (DN 40).

    f. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.

    g. Fixture Support: Sink.

B. Vitreous-China Surgeons' Scrub Sinks:

1. Description: Wall-mounting, sink-type medical plumbing fixture.

    a. Size: 28 by 22 inches (710 by 560 mm) **OR** 30 by 22 inches (760 by 560 mm), **as directed**, with back or ledge with 1 faucet hole.

    b. Color: White.

    c. Faucet: Chrome-plated-brass, gooseneck-type matching fixture.

    d. Operation: Foot-pedal **OR** Knee, **as directed**, control.

    e. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.

    f. Drain: Grid, NPS 1-1/2 (DN 40).

    g. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.

    h. Fixture Support: Sink.

2.16 SURGEONS' INSTRUMENT SINKS

A. Description: Wall-mounting, stainless-steel, sink-type medical plumbing fixture. Include instrument tray on each side.

1. Size: 28 by 20 inches (710 by 510 mm) with 1 hole for deck-mounting faucet.

2. Faucet: Chrome-plated-brass, gooseneck type matching fixture with knee **OR** foot-pedal, **as directed**, control for mixing hot- and cold-water supplies.

3. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.

4. Drain: Grid, NPS 1-1/2 (DN 40).

5. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.

6. Fixture Support: Sink.

2.17 BATHING UNITS

A. Institutional Bath Tubs:

1. Description: Enameled, cast-iron, island medical plumbing fixture with separate wall-mounting faucet.

    a. Size: 66 by 30 by 18 inches (1680 by 765 by 455 mm).

    b. Base: Enameled, cast iron to raise rim of bathtub to 28 inches (710 mm) above the floor.

    c. Faucet: Shower **OR** Sink, **as directed**, modified to include tub filler spout.

    d. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops. Include atmospheric vacuum breaker.

    e. Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.

    f. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.

B. Bathing Units:

1. Description: Plastic-tub, institutional side-entry bath **OR** whirlpool-bath, **as directed**, fixture with integral controls.

    a. Tub Size: 60 by 30 inches (1525 by 765 mm).

    b. Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.

    c. Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.

    d. Drain: NPS 1-1/2 (DN 40) and NPS 2 (DN 50).

    e. Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, cast-brass P-trap, waste to wall, and wall flange. Include combined drain piping if two drains.

C. Bathing Units:

1. Description: Plastic-tub, institutional side-entry **OR** transfer-lift-entry **OR** slide-on-entry, **as directed**, adjustable-height **OR** fixed-height, **as directed**, bath fixture with integral controls.

    a. Tub Size: 60 by 30 inches (1525 by 765 mm).

b. Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.

c. Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.

d. Drain: NPS 1-1/2 (DN 40) and NPS 2 (DN 50).

e. Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, cast-brass P-trap, waste to wall, and wall flange. Include combined drain piping if two drains.

f. Lift System: Not required.

D. Bathing Units:

1. Description: Plastic-tub, institutional front-entry shower fixture with integral controls.

a. Cabinet Size: 35 by 41 inches (889 by 1041 mm).

b. Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.

c. Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.

d. Drain: NPS 2 (DN 50).

e. Drain Piping: NPS 2 (DN 50) cast-brass P-trap, waste to wall, and wall flange.

E. Residential Bath Tubs:

1. Description: Plastic island or against-wall-installation, **as directed**, medical plumbing fixture with side door, seat, and separate wall-mounting faucet.

a. Size 1

1) Size: Approximately 60 by 32 by 21 inches (1525 by 815 by 535 mm).

2) Seat: Integral.

3) Drain Location: Left **OR** Right, **as directed**, end.

b. Size 2

1) Size: Approximately 60 by 42 by 24.5 inches (1525 by 1070 by 620 mm).

2) Seat: Integral bench **OR** None, **as directed**.

3) Drain Location: Right end.

c. Material: PMMA.

d. Skirt: Front only **OR** Full, on three sides, **as directed**.

e. Door: Side opening with rubber sealing gasket.

f. Faucet: Shower **OR** Sink, **as directed**, modified to include tub filler spout.

g. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops. Include atmospheric vacuum breaker.

h. Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.

i. Drain Piping: NPS 1-1/2 (DN 40) cast-brass P-trap and 0.045-inch- (1.1-mm-) thick, tubular-brass waste to wall.

2.18 SITZ BATHS

A. Description: Pedestal-mounting **OR** Wall-mounting, **as directed**, vitreous-china, perineal bath medical plumbing fixture.

1. Color: White.
2. Drain: NPS 1-1/2 (DN 40) with removable overflow attachment.
3. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; waste to wall; and wall flange.
4. Fixture Support: Sink.
5. Faucet:
   a. Description: Wall-mounting, single-lever-handle, thermostatic-mixing-valve faucet with concealed supplies and wall-mounting thermometer.
      1) Material: Brass body and escutcheon.
      2) Flow Rate: Modified to 1.5 gpm (5.7 L/min.) maximum, unless otherwise indicated.
      3) Finish: Polished chrome plate.
      4) Temperature Indicators: Color-coded for hot and cold water.
6. Exposed Piping: Chrome-plated; brass pipe or copper tube.

2.19 BEDPAN WASHING EQUIPMENT

A. Bedpan Washers/Sanitizers:

1. Description: Recessed-mounting **OR** On-wall-mounting **OR** Pedestal-mounting, **as directed**, medical plumbing fixture for cleaning bedpans and urinals having cast-iron chamber and waste assembly with spray nozzles and enameled-steel **OR** stainless-steel, **as directed**, front panel and cover box.
   a. Controls: Electric, 120-V ac, automatic operation with timer, solenoid valves, and circuit breaker.
   b. Door Mechanism: Foot-pedal operation.
   c. Supplies: NPS 1 (DN 25) cold water and NPS 3/8 (DN 10) hot water **OR** steam, **as directed**.
   d. Drain: NPS 3 (DN 80) P-trap and soil pipe.
   e. Atmospheric Vent: NPS 2 (DN 50).
   f. Mounting Hardware: Matching fixture mounting arrangement.
   g. Accessories:

1) Bedpan Rack(s): One **OR** Two, **as directed**.

2) Urinal Rack(s): One **OR** Two, **as directed**.

3) Drain Tray(s): One **OR** Two, **as directed**.

B. Bedpan Washers/Disinfectors:

1. Description: Freestanding-mounting **OR** On-wall-mounting **OR** Undercounter-mounting, **as directed**, medical plumbing fixture for cleaning bedpans and urinals; with steam generator, pump, and spray nozzle.

a. Controls: Electric, automatic operation.

b. Cabinet: Stainless steel.

c. Wash Chamber: Stainless steel.

d. Supplies: NPS 1/2 (DN 15) cold water and NPS 1/2 (DN 15) hot water.

e. Drain: NPS 4 (DN 100) P-trap and soil pipe.

f. Mounting Hardware: Matching fixture mounting arrangement.

2.20 HYDROTHERAPY WHIRLPOOLS

A. Podiatry Whirlpools:

1. Description: Stationary, stainless-steel tank for feet and ankles.

a. Water Capacity: 15 gal. (57 L).

b. Drain: Waste connection.

c. Controls.

d. Thermometer: Control panel or tank mounted.

e. One electric turbine ejector.

B. Upper-Extremity Whirlpools:

1. Description: Stationary, pedestal-mounted, stainless-steel tank for arms, hands, and elbows.

a. Water Capacity: 25 gal. (95 L).

b. Drain: Waste connection.

c. One arm support.

d. Controls.

e. Thermometer: Control panel or tank mounted.

f. One electric turbine ejector.

C. High-Tank Body Whirlpools:

1. Description: Stationary, stainless-steel tank for legs, hip, and back.

a. Water Capacity: 105 gal. (397 L).

- b. Drain: Waste connection.
- c. Controls.
- d. Thermometer: Control panel or tank mounted.
- e. One electric turbine ejector.

D. Low-Tank Body Whirlpools:

1. Description: Stationary, extended-length stainless-steel tank for legs, hip, and lower back.
    - a. Water Capacity: 105 gal. (397 L).
    - b. Drain: Waste connection.
    - c. Controls.
    - d. Thermometer: Control panel or tank mounted.
    - e. Head rest.
    - f. One electric turbine ejector.

E. Small, Hubbard Immersion Tanks:

1. Description: Stationary, butterfly-shaped tank, for full-body massage
    - a. Tank Dimensions: 93 by 64 by 22 inches (2362 by 1626 by 560 mm).
    - b. Overall Height: 34 to 38 inches (864 to 965 mm).
    - c. Water Capacity: 268 gal. (1014 L).
    - d. Material: Stainless steel.
    - e. Supports: Legs or base.
    - f. Controls.
    - g. Thermometer: Control panel or tank rim mounted.
    - h. Supply: Over-the-rim fill spout.
    - i. Drains: Two waste connections.
    - j. Electric Turbine Ejectors: Two; one rail mounted on each side.
    - k. Thermostatic, mixing-valve assembly.
    - l. Hose and hand-held shower.
    - m. Wash-out-hose assembly.
    - n. Stretcher lift.
    - o. Overhead electric, **as directed**, hoist.

F. Medium, Hubbard Immersion Tanks:

1. Description: Stationary, butterfly-shaped tank, for full-body massage.
    - a. Tank Dimensions: 100 by 73 by 24 inches (2540 by 1854 by 610 mm).
    - b. Overall Height: 34 to 38 inches (864 to 965 mm).
    - c. Water Capacity: 377 gal. (1468 L).
    - d. Material: Stainless steel.
    - e. Supports: Legs or base.
    - f. Controls.
    - g. Thermometer: Control panel or tank rim mounted.
    - h. Supply: Over-the-rim fill spout.
    - i. Drain: One waste connection.
    - j. Electric Turbine Ejector: One, panel mounted.
    - k. Thermostatic, mixing-valve assembly.
    - l. Hose and hand-held shower.
    - m. Wash-out-hose assembly.
    - n. Stretcher lift.
    - o. Overhead electric, **as directed**, hoist.

G. Large, Hubbard Immersion Tanks:

1. Description: Stationary, butterfly-shaped tank, for full-body massage.
    - a. Tank Dimensions: 106 by 77 by 22 inches (2692 by 1956 by 560 mm).
    - b. Overall Height: 34 inches (864 mm).
    - c. Water Capacity: 425 gal. (1609 L).
    - d. Material: Stainless steel.
    - e. Supports: Legs or base.
    - f. Controls.
    - g. Thermometer: Control panel or tank rim mounted.
    - h. Supply: Over-the-rim fill spout.
    - i. Drain(s): One or two waste connections.
    - j. Electric Turbine Ejectors: Two; one rail mounted on each side.
    - k. Thermostatic, mixing-valve assembly.
    - l. Hose and hand-held shower.
    - m. Wash-out-hose assembly.

n. Stretcher lift.

o. Overhead electric, **as directed**, hoist.

H. Full-Body Immersion Tanks:

1. Description: Stationary, rectangular tank, for full-body massage

a. Tank Dimensions: 90 by 32 by 19 inches (2286 by 813 by 483 mm) **OR** 95 by 41 by 22 inches (2413 by 1041 by 560 mm), **as directed**.

b. Overall Height: 32 or 34 inches (813 or 860 mm).

c. Water Capacity: 195 gal. (738 L) **OR** 260 gal. (984 L), **as directed**.

d. Material: Stainless steel.

e. Supports: Legs or base.

f. Controls.

g. Thermometer: Control panel or tank rim mounted.

h. Supply: Over-the-rim fill spout.

i. Drain(s): One or two waste connections.

j. Electric Turbine Ejector: One, tank mounted at end **OR** on rail **OR** on side, **as directed**.

k. Thermostatic, mixing-valve assembly.

l. Hose and hand-held shower.

m. Wash-out-hose assembly.

n. Stretcher lift.

o. Overhead electric, **as directed**, hoist.

2.21 OUTLET BOXES

A. Dialysis Equipment Outlet Boxes:

1. Description: Recessed-mounting outlet box with water supply and drain connections.

a. Box and Faceplate: Stainless steel.

b. Supply Fitting(s): 1 **OR** 2, **as directed**, NPS 1/2 (DN 15) PVC ball valve(s) and adapter with male hose-thread outlet.

c. Drain: NPS 2 (DN 50) standpipe, P-trap, and direct waste connection to drainage piping.

2. Reinforcement: 2-by-4-inch (50-by-100-mm) fire-retardant-treated-wood blocking between studs. Fire-retardant-treated wood blocking is specified in Division 06 Section "Rough Carpentry".

2.22 MORGUE EQUIPMENT

A. Autopsy Tables:

1. Description: Pedestal stainless-steel table with sink; designed for downdraft ventilation.

a. Material: Stainless steel.

b. Overall Size: Approximately 88 by 30 inches (2250 by 760 mm) with deck faucet holes.

c. Faucet: Deck mounted with wrist- or elbow-blade handles.

d. Aspirator: Deck mounted.

e. Removable body supports.

f. Rinse Assembly: Deck-mounted faucet with hose.

g. Disposer: Not required **OR** Required, **as directed**.

h. Fixture Support: Sink.

i. Receptacle: Duplex, hospital grade with ground-fault interruption.

j. Supplies: Chrome-plated copper tubes or flexible connectors, **as directed**, with atmospheric vacuum breakers and stops.

k. Drain: Chrome-plated, cast-brass P-trap and waste to wall.

B. Dissecting Sinks

1. Description: Wall-mounting sink with backsplash.

a. Material: Stainless steel.

b. Overall Size: 84 by 28 inches (2134 by 711 mm) with back faucet holes.

c. Sink Size: Approximately 30 inches (763 mm) wide.

d. Equipment drawer.

e. Faucet: Back mounted with wrist- or elbow-blade handles.

f. Aspirator: Back mounted.

g. Rinse Assembly: One back-mounted faucet with hose.

h. Disposer: Not required **OR** Required, **as directed**.

i. Fixture Support: Sink.

j. Supplies: Chrome-plated copper tubes or flexible connectors, **as directed**, with atmospheric vacuum breakers and stops.

k. Drain: Chrome-plated, cast-brass P-trap and waste to wall.

l. Back-mounted, hand-held-type eye wash.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Assemble medical plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install shower flow-control fittings with specified maximum flow rates in shower arms.

N. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

O. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results For Plumbing".

P. Set showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results For Plumbing".

Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants".

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 14.. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from domestic water piping to medical plumbing fixtures.

C. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.

D. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".

E. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

3.03 FIELD QUALITY CONTROL

A. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.

B. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed medical plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.04 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning medical plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.05 CLEANING

A. Clean medical plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

  1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

  2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.06 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of medical plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 43 39 00

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SECTION 22 60 00 00 - EMERGENCY SHOWER AND EYE WASH EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Provide all materials and labor for emergency shower and eye wash equipment, and associated piping, supports, valves, and accessories to provide complete, operable, and code compliant installation that is acceptable to the authorities having jurisdiction.

B. Emergency shower and eye wash equipment addressed by this specification shall be installed within conditioned or ventilated spaces having ambient temperatures between 60 and 100 degrees Fahrenheit.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. 2015 Edition of the International Plumbing Code.
2. ANSI Standard: Comply with ANSI Z358.1-2004, "Emergency Eyewash and Shower Equipment."
3. Texas Department of Licensing and Regulation, Texas Accessibility Standards of the Architectural Barriers Act, Article 9102, Texas Civil Statutes.
4. Americans with Disabilities Act, 28 CFR Part 35 Nondiscrimination on the Basis of Disability in State and Local Government Services, Final Rule, as published in the Federal Register.
5. ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities" relative to plumbing fixtures for people with disabilities.
6. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.04 QUALITY ASSURANCE

A. All materials shall be new, undamaged, and free of rust. Protect installed products and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc. Remove dirt and debris as Work progresses.

B. Manufacturer Qualifications: Company shall have minimum three (3) years documented experience specializing in manufacturing the products specified in this section.

C. Installer Qualifications: Company shall have minimum three (3) years documented experience specializing in performing the Work of this Section. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

1.05 SUBMITTALS

A. Product Data:

1. Provide Code and Standards compliance, component dimensions, service sizes and finishes.

B. Record Documents:

1. Record actual locations of supply isolation valves, emergency shower and eye wash equipment installed.

2. Provide full written description of manufacturer’s warranty.

3. Manufacturer’s Installation Instructions: Indicate assembly and support requirements, adjustment and testing procedures.

C. Operation and Maintenance Data:

1. Include installation instructions, exploded assembly views, servicing requirements, inspection data, installation instructions, spare parts lists, replacement part numbers and availability, location and contact numbers of service depot, for all components installed.

2. Include cleaning, testing and adjustment procedures for all components installed.

1.06 DELIVERY, STORAGE AND HANDLING

A. Accept equipment and materials on Site in shipping containers and maintain in place until installation.

B. Protect installed equipment from damage and/or entry of foreign materials by temporary covers during the construction phase of this Project.

C. Do not allow use of installed equipment for any reason, other than testing, during the construction phase of this Project.

D. Protect all materials before and after installation from exposure to rain, freezing temperatures and direct sunlight.

1.07 EXTRA MATERIALS

A. Provide manufacturer’s drench shower tester for each emergency shower installed.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide emergency equipment as indicated and scheduled on the Contract Drawings and as specified herein.

C. Pressure ratings of equipment and related accessories shall be suitable for the anticipated system pressures in which they are installed.

D. Equipment and components of same type shall be product of one (1) manufacturer.

E. All emergency equipment shall meet American with Disabilities Act (ADA) accessibility requirements for activation of controls and height of eye/face outlets with the following exceptions:

1. Equipment within boiler rooms or central plants.
2. Eye/face outlets located in countertops that are not required to be accessible.

F. Emergency equipment activation devices shall be designed so that the flushing water remains on without requiring the use of the operator's hands. The valve shall be designed to remain activated until intentionally shut off.

G. Shower head flow rate shall be 20 gallons per minute at a minimum 30 pounds per square inch water pressure.

H. Eye Wash unit shall provide flushing fluid at 0.4 gallons per minute at a minimum 30 pounds per square inch water pressure.

I. Face Wash unit shall provide flushing fluid at 3 gallons per minute at a minimum 30 pounds per square inch water pressure.

J. Provide floor drains or other means of drainage for emergency showers and eyewash equipment.

2.02 ACCEPTABLE MANUFACTURERS:

A. Haws

B. Or approved equal

2.03 COMBINATION EMERGENCY SHOWER AND EYE/FACE WASH:

A. Barrier-free design with coated galvanized steel piping; 10 inch diameter yellow impact-resistant plastic shower head; Chrome-plated brass 1 inch IPS stay-open ball-type shower valve operated by stainless steel pull rod having triangular handle; 10 inch diameter stainless steel eye wash bowl; chrome-plated brass spray head assembly with twin, soft flow, eye wash heads and protective spray head covers; integral flow control capable of maintaining uniform flow under varying water supply conditions from 30-90 psig; Chrome-plated 1/2 inch IPS stay-open ball-type eye wash valve hand operated by a large, highly visible safety yellow PVC push handle; chrome-plated circular face spray ring; universal identification sign; inspection tag, and 1-1/4 inch water supply connection.

B. Combination emergency shower and eye/face wash units shall be HAWS 8300 or approved equal by an acceptable manufacturer listed herein.

2.04 DRENCH SHOWER WITH HORIZONTAL SUPPLY:

A. Barrier-free design with coated galvanized steel piping; 10 inch diameter yellow impact-resistant plastic shower head; Chrome-plated brass 1 inch IPS stay-open ball-type shower valve operated by stainless steel pull rod having triangular handle; universal identification sign; inspection tag, and 1 inch water supply connection.

B. Drench shower units with horizontal supply shall be HAWS 8133H or approved equal by an acceptable manufacturer listed herein.

2.05 DRENCH SHOWER - FLUSH-MOUNTED:

A. Barrier-free design with coated galvanized steel piping; 12-7/8 inch diameter flanged stainless steel shower head; Chrome-plated brass 1 inch IPS stay-open ball-type shower valve operated by stainless steel pull rod having triangular handle; universal identification sign; inspection tag, and 1 inch water supply connection.

B. Flush-mounted drench shower units shall be HAWS 8164 or approved equal by an acceptable manufacturer listed herein.

2.06 DRENCH SHOWER WITH VERTICAL SUPPLY:

A. Barrier-free design with 10 inch diameter stainless steel shower head; stainless steel 1 inch IPS stay-open ball-type shower valve operated by stainless steel pull rod having triangular handle; universal identification sign; inspection tag, and 1 inch water supply connection.

B. Drench shower units with horizontal supply shall be HAWS 8133V or approved equal by an acceptable manufacturer listed herein.

2.07 DRENCH SHOWER TESTER:

A. Watertight, chemical resistant 84 inch long funnel constructed of Tyvek®, with weighted bottom and 6 foot telescoping aluminum handle.

B. Drench shower testers shall be Bradley Model S19-330ST or approved equal by an acceptable manufacturer listed herein.

2.08 EYEWASH - SWING-TYPE, COUNTER MOUNTED:

A. Chrome-plated brass spray head assembly with twin, soft flow, eye wash heads and protective spray head covers; integral flow control capable of maintaining uniform flow under varying water supply conditions from 30-90 psig; Chrome-plated 1/2 inch IPS stay-open ball-type eye wash valve hand operated by a large, highly visible stainless steel push handle; chrome plated brass pipe and fittings; universal identification sign; inspection tag, and 1/2 inch water supply connection.

B. Swing-type eyewash units shall HAWS 7612 or 7612 LH or approved equal by an acceptable manufacturer listed herein.

2.09 EYE/FACE WASH - DECK/COUNTER TOP MOUNTED:

A. Stainless steel 13-5/8 inch diameter bowl; twin perforated disc eye/face wash heads with protective pop-off spray head covers; integral flow control capable of maintaining uniform flow under varying water supply conditions from 30-90 psig; Chrome-plated 1/2 inch IPS stay-open ball-type valve operated by stainless steel push down handle; coated galvanized steel pipe and fittings; dome type strainer; 1-1/4 inch drain fitting; universal identification sign; inspection tag, and 1/2 inch water supply connection.

B. Counter top mounted bowl type eye/face wash units shall be HAWS 7760B or approved equal by an acceptable manufacturer listed herein.

2.10 EYE/FACE WASH - WALL MOUNTED:

A. Barrier-free design with stainless steel 10 inch diameter bowl; stainless steel wrap-around skirt; chrome-plated brass spray head assembly with twin, soft flow, eye wash heads and protective spray head covers; integral flow control capable of maintaining uniform flow under varying water supply conditions from 30-90 psig; Chrome-plated 1/2 inch IPS stay-open ball-type eye wash valve hand operated by a large, stainless steel push handle; chrome-plated circular face spray ring; chrome plated brass pipe and fittings; dome type strainer; 1-1/4 inch drain fitting, wall tube and trap; universal identification sign; inspection tag, and 1/2 inch water supply connection.

B. Wall mounted bowl type eye/face wash units shall be HAWS 7760BT or approved equal by an acceptable manufacturer listed herein.

2.11 EYEWASH - WALL CABINET MOUNTED:

A. Barrier-free design with stainless steel cabinet and doors; lockable, hinged bottom panel for plumbing access; chrome-plated brass spray head assembly with twin, soft flow, eye wash heads and protective spray head covers; integral flow control capable of maintaining uniform flow under varying water supply conditions from 30-90 psig; Chrome-plated 1/2 inch IPS stay-open ball-type eye wash valve activated by pulling door down 90 degree; chrome plated brass pipe and fittings; 1-1/4 inch drain fitting and trap; brass water stop valve; universal identification sign; inspection tag, and 1/2 inch water supply connection.

B. Wall cabinet mounted eyewash units shall be HAWS 8356WC or approved equal by an acceptable manufacturer listed herein.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine roughing-in for plumbing piping systems to verify actual locations of piping connections prior to installation of emergency equipment. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Coordinate location of emergency equipment with General Contractor to allow identification of required clear floor space area for emergency shower access.

C. Coordinate location of counter mounted emergency eyewash and eye/face wash fixture with General Contractor for proper drilling/cutting of casework to allow drenching water to spill into sink.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install in emergency shower, eyewash and eye/face wash equipment in accordance with manufacturer’s published instructions.

D. Locate emergency equipment on a level surface area for user.

E. Safety drenching equipment shall not be located within eighteen (18) inches of electrical apparatus, telephones, thermostats, or power outlets.

F. Emergency shower heads shall be positioned 82 inches – 96 inches from floor. The center of the spray pattern shall be located at least 16 inches from wall or nearest obstruction.

G. Emergency eyewash nozzles shall be positioned 33 inches- 45 inches from floor and at least 6" from wall or nearest obstruction.

H. Connect potable water supply having a temperature between 60 degrees F. and 100 degrees F. to emergency equipment. Potable water supply shall be capable of supplying adequate flushing to meet requirements of reference standards.

I. Provide hydraulic shock absorbers in water supply lines to each emergency shower. Locate and size in accordance with PDI-WH-201 Standard and manufacturer’s published recommendations.

J. Provide and accessible ball type shutoff valve in individual water supply line serving safety drenching equipment. Valves shall be labeled for identification and locked in the open position.

K. Provide and install stainless steel escutcheons on piping wall and ceiling penetrations in exposed, finished locations.

L. Coordinate with General Contractor for location and installation of emergency equipment identification signage and inspection tags.

3.03 TESTING

A. Adjust or replace fixture flow regulators for proper flow.

B. After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve required flows and temperatures.

C. Report test results in writing.

END OF SECTION 22 60 00 00

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SECTION 22 60 00 00A - HIGH PURITY WATER SYSTEMS (RO)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. The water conditioning system/supplier shall be totally responsible for the supply and installation of the water treatment system to include the central RO water system, the building supply and return loop system, the final connection to the RO water outlet and quality assurance/quality controls of the entire system to assure meeting quality standards for CAP/NCCLS reagent water Specifications Type III at the point of use.

B. The system/supplier shall guarantee that the water quality coming from the central system is the same quality at any point of use in the RO water loop system at initial start-up.

C. Provide an RO system with capacities and electrical characteristics as scheduled on Contract Drawings. Scheduled gallons per day (24 hour period) shall be based on a feed water temperature of 77 degrees F.

D. Provide complete system as manufactured by WRC LLC dba Water Resources Company or Osmonics.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. 2015 Edition of the International Plumbing Code.
2. Texas Water Code Chapter 37
3. Texas Health & Safety Code Chapter 341
4. Title 30 Texas Administrative Code, Chapter 30, Subchapter H
5. Underwriters Laboratories Listings.
6. 2005 Edition of the National Electric Code
7. ASME - Boiler and Pressure Vessel Code.
8. ASTM D 3222 - Standard Specifications for Unmodified PVDF molding material.
9. ASTM D 638 - Standard Test Method for Tensile Properties of Plastic.

10. ASTM D 790 - Standard Test Method of Flexural Properties of Unreinforced and Reinforced Plastics and Electric Insulating Materials.

1.04 QUALITY ASSURANCE

A. Manufacturer’s name and contact information shall be permanently marked on equipment.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section.

D. Installer Qualifications:

1. Company shall have minimum three years documented experience specializing in performing the Work of this section and be licensed by the State of Texas to install water treatment equipment.

2. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

3. All installers of water treatment equipment must meet the qualifications and be licensed according to the State of Texas.

1.05 SUBMITTALS

A. Product Data:

1. Code and Standards compliance, manufacturer's data for pipe, fittings, valves, controls, water testing kits. and all furnished specialties, and accessories.

2. Include rated pressures, temperatures, capacities and operating characteristics.

3. Manufacturer’s installation instructions.

B. Record Documents:

1. Shop Drawings: Include plans, elevations, sections, details, and connections to piping systems. Indicate size, profiles, and dimensional service requirements of system based on the specific components being installed.

2. Wiring Diagrams: Power, signal, and control wiring.

3. Manufacturer Certificates: Signed by manufacturers certifying that components comply with requirements.

4. Maintenance service agreement.

5. Provide full written description of manufacturer’s warranty including special warranty specified in this Section.

6. Source and Site quality-control test reports.

C. Operation and Maintenance Data:

1. Include manufacturer’s operation instructions, start-up data, trouble-shooting check lists.
2. Include system components manufacturer’s literature, servicing requirements, Record Documents, installation instructions, exploded assembly views, replacement part numbers and availability.
3. Include cleaning procedures, preventive maintenance schedule, preventive maintenance recommendations and procedures.
4. Identify place of purchase, location and contact numbers of service depot and technical support for each product installed.

1.06 DELIVERY, STORAGE AND HANDLING

A. Accept delivery of packaged high purity water equipment, storage vessel, etc. on Site in factory fabricated containers with shipping skids and pipe end protectors in place. Inspect for damage. Comply with manufacturers rigging and installation instructions.

B. All components and materials shall be new, undamaged, and free of rust.

C. Provide temporary protective coating and end plugs on valves not packaged within containers. Maintain in place until installation.

D. Provide temporary end caps and closures on openings, connections, pipe and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work and isolating parts of completed system.

F. Protect all components and materials that are to be installed within this project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.

1.07 WARRANTY

A. Warranty: Include, but not limited to, coverage for the RO water system, storage tank, pumps, softener system, all associated controls and accessories.

B. The system/supplier shall be responsible for the operation of the water treatment system for a period of one year from the date of Substantial Completion. During this period the system/supplier shall also be responsible for periodic ongoing training of the building maintenance personnel. The vendor shall supply all the necessary consumables for the first year of operation and include the labor to change out the consumables. A daily log indicating the performance of the system will be kept by the building maintenance personnel and reviewed by the system/supplier on a monthly basis.

1.08 MAINTENANCE SERVICE

A. Submit four copies of manufacturer's "Agreement for Continued Service and Maintenance," before Substantial Completion, for Owner's acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing to include replacing materials and equipment. Include one-year term of agreement with option for one-year renewal.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. The RO water central system will consist of the following components and include the interconnecting piping, valves, fittings, instrumentation, control wiring and electrical wiring to the equipment.

1. Piping, Valves, Fittings
2. Multi-layer Filter
3. Activated Carbon Filter
4. Water Softeners
5. Reverse Osmosis System
6. Storage Tank
7. Level Controllers
8. Repressure Pumps
9. Ultraviolet Sterilizers
10. Final Filters
11. Instrumentation
12. Control Panel

2.02 PIPING, VALVES AND FITTINGS

A. Pipe, valves and fittings from the reverse osmosis unit to include the supply and return building loop system shall be SYGEF, SDR-11 through SDR-21 (or pipe schedule equivalent), flame resistant, self-extinguishing polyvinylidene fluoride (PVDF) with heat fusion socket connections.

B. Installation practices, including support spacing and joint fusion shall be in compliance with manufacturer’s printed recommendations.

C. Material from which pipe, fitting and valves are manufactured shall conform to the standards of ASTM D 3222. The PVDF material shall have a tensile strength of 7,800 psi and a flexural strength of 10,750 psi when tested at 73°F according to ASTM D 638 and ASTM D 790 and shall be as manufactured by George Fischer Company or Simtech.

D. To ensure installation uniformity, all system piping components shall be the products of one manufacturer.

E. All piping shall be thoroughly rinsed and flushed to remove all dirt and debris before installation. After installation the Contractor shall flush the entire piping system with deionized water to the satisfaction of The University.

F. Valves shall be diaphragm valve type and shall be manufactured of the same virgin, unpigmented molding compound as the fittings to assure compatibility.

G. Diaphragm valves shall have PVDF body, PTEF diaphragm, seals, and seats. Valves shall carry a pressure rating of 150 psi at a minimum of 68°F, and shall be of socket fusion design as manufactured by George Fischer Company or Simtech.

H. The reverse osmosis pretreatment shall be piped by the system/supplier PVDF and install a pressure gauge and test port before and after each piece of equipment. Each unit shall be installed using a “H” type 3-valve bypass. The person doing this installation or person supervising this installation must possess a currently valid Texas Department of Health Class III Certificate.

PART 3 - EXECUTION

3.01 PREPARATION

A. Important Safety Precautions: Prior to any operations, be sure that protective equipment and safety shower and/or hose stream is available for personnel protection. Follow chemical manufacturer's safety instructions. Tag all distribution valves with the following information: "DANGER-Men Working on Equipment-DO NOT TOUCH".

3.02 CLEANING AND DISINFECTION

A. Semi-conductor grade 35 percent unstabilized hydrogen peroxide diluted to 5 percent with deionized water shall be used as the disinfectant. Sodium hypochlorite is not acceptable. Hydrogen peroxide disinfection solution shall be placed in storage tanks, pumped through 0.2 micron absolute membrane filters and into the PVDF piping system. All valves and sample ports shall be opened to purge distribution lines of gases.

B. Hydrogen peroxide solution shall recirculate for 24 hours. Outlets and sample ports shall be opened and closed each 6 hours for two minutes. At the end of the 24 hour recirculation period, valves and sample ports shall be opened and system shall be drained. Flush system with deionized water. At the completion of the disinfection process, the RO system and DI water system shall be on line with equipment ready for operation and distribution piping system in the recirculation mode.

3.03 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

3.04 START-UP AND SERVICE

A. Make available the service of qualified personnel to supervise the installation and start-up of the entire system. Provide qualified personnel to train Owner maintenance and operations personnel in the maintenance and operation of the entire system. When start-up is complete and the system is operational, notify Owner that the acceptance test will be started. Provide all chemicals, filters and expandable materials necessary to perform start-up service. Provide necessary chemical test kits as required by maintenance manuals in corrosion-resistant metal cabinet mounted on wall.

3.05 TESTING

A. Test the system under design operating conditions for a period of 24 hours and check for leaks. After all leaks have been repaired, retest the system until proven airtight.

END OF SECTION 22 60 00 00a

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Specification	Specification Description
23 01 10 00	Sequence of Operation
23 01 10 00a	Testing, Adjusting, And Balancing
23 01 30 51	Air Distribution System Cleaning
23 05 00 00	Motors
23 05 13 00	Electrical Renovation
23 05 19 00	Meters Guages HVAC Piping
23 07 13 00	Ductwork Insulation
23 07 13 00a	System Testing Adjusting Balancing HVAC
23 11 23 00	Facility Natural Gas Pipng
23 21 13 00	Hydronic Piping
23 21 13 23	Hydronic Specialties
23 21 16 00	Piping Valves Fittings
23 22 23 13	Steam Condensate Pumps
23 31 13 13	Ductwork
23 31 13 33	Duct Accessories
23 34 19 00	High Plume Laboratory Exhaust System
23 34 23 00	Power Ventilators
23 36 00 00	Air Terminal Units
23 36 13 00	Fan Coil Units
23 36 13 00a	Air Outlets and Inlets
23 84 13 00	Humidifiers

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SECTION 23 01 10 00 - SEQUENCE OF OPERATION

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for sequence of operation. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. This Section includes control sequences for HVAC systems, subsystems, and equipment.

C. Definitions
  1. DDC: Direct digital control.
  2. VAV: Variable air volume.

D. Heating Control Sequences
  1. Heating-Water Supply Temperature Control:
    a. Input Device: Thermostat **OR** Thermistor temperature sensor **OR** Resistance temperature sensor, **as directed**.
    b. Output Device: Control valve.
    c. Action: Modulate control valve to maintain heating-water supply temperature.
    d. Display:
      1) Heating-water supply temperature.
      2) Heating-water supply temperature set point.
      3) Control-valve position.
  2. Heating-Water Supply Temperature Reset:
    a. Input Device: Electric, outdoor-air-reset controller **OR** Outdoor-air sensor, **as directed**.
    b. Output Device: Unitary controller **OR** DDC system software, **as directed**.
    c. Action: Reset heating-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:
      1) 180 deg F heating water when outdoor-air temperature is 30 deg F.
      2) 130 deg F heating water when outdoor-air temperature is 75 deg F.
      3) 150 deg F minimum, heating-water temperature.
    d. Display:
      1) Outdoor-air temperature.
      2) Heating-water supply temperature.
      3) Heating-water supply temperature set point.
  3. Control Primary Circulating Pump(s):
    a. Input Device: Thermostat **OR** DDC system, **as directed**.
    b. Output Device: Starter **OR** DDC system command to starter, **as directed**, relay.
    c. Action: Energize pump(s) at outdoor-air temperatures below 65 deg F (18 deg C).
    d. Display:
      1) Outdoor-air temperature.
      2) Operating status of primary circulating pump(s).

E. Central Refrigeration Equipment Sequences
  1. Start and Stop Condenser-Water Pump(s):
    a. Enable: Allow pump to start when water is in cooling tower:
      1) Input Device: Water pressure transducer.
      2) Output Device: Hard wired through motor starter; DDC system binary output, **as directed**.
      3) Action: Confirm water in cooling-tower sump.
    b. Enable: When outdoor-air temperature conditions are met:

        1) Input Device: Space thermostat **OR** DDC system outdoor-air temperature, **as directed**.
        2) Output Device: Hard wired through motor starter; DDC system binary output, **as directed**.
        3) Action: Confirm outdoor-air temperature is above 50 deg F (10 deg C).
    c. Enable: When demand conditions are met:
        1) Input Device: DDC system software demand.
        2) Action: Confirm cooling demand from ventilation system(s).
    d. Initiate:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Time clock **OR** Binary output, **as directed**.
        3) Action: Energize pump(s).
    e. Display:
        1) Low-level cooling-tower sump alarm.
        2) Outdoor-air temperature.
        3) Cooling (software) demand indication.
        4) Time and time schedule.
        5) Condenser-water pump(s) on-off status.
        6) Condenser-water pump(s) on-off indication.
2. Start and Stop Chilled-Water Pump(s):
    a. Input Device: Flow switch in condenser-water circuit.
    b. Output Device: Starter **OR** DDC system command to starter, **as directed**, relay.
    c. Action: Energize pump(s).
    d. Display:
        1) Chilled-water flow indication.
        2) Chilled-water pump(s) on-off status.
        3) Chilled-water pump(s) on-off indication.
3. Start and Stop Cooling-Tower Fans(s):
    a. Input Device: Flow switch in condenser-water circuit.
    b. Output Device: Starter **OR** DDC system command to starter, **as directed**, relay.
    c. Action: Energize fan(s).
    d. Display:
        1) Condenser-water flow indication.
        2) Cooling-tower fan(s) on-off indication.
4. Start and Stop Refrigeration Machine(s):
    a. Input Device: Flow switch in condenser-water circuit. Flow switch in chilled-water circuit, **as directed**.
    b. Output Device: Refrigeration **OR** DDC system command to refrigeration, **as directed**, machine terminal strip.
    c. Action: Energize refrigeration machine(s) internal control circuit.
    d. Display:

    e. Condenser-water flow indication.
    f. Chilled-water flow indication.
    g. Refrigeration machine on-off indication.
    h. Chilled-water supply and return temperature.
    i. Chilled-water temperature control-point adjustment.
5. Start and Stop Chiller(s):
    a. Input Device: Flow switches in condenser-water and chilled-water circuit.
    b. Output Device: Chiller **OR** DDC system command to chiller, **as directed**, terminal strip.
    c. Action: Energize chiller internal control circuit.
    d. Display:
        1) Condenser-water flow indication.
        2) Chilled-water flow indication.
        3) Chiller(s) on-off status.
        4) Chiller(s) on-off indication.

    5) Chilled-water supply and return temperature.
    6) Chilled-water temperature control-point adjustment.
6. Alternate Chiller(s):
    a. Input Device: Electric alternator **OR** DDC system software, **as directed**.
    b. Output Device: Chiller **OR** DDC system command to chiller, **as directed**, terminal strip.
    c. Action: Operate chiller(s) on lead-lag, alternating each startup.
    OR
    Action: Adding and dropping chiller(s) as follows: <**Insert sequence and parameters**.>
    d. Display: Chiller(s) on-off indication.
7. Alarm Chiller(s) Start Failure:
    a. Input Device: Chiller control panel terminal strip contact **OR** software signal, **as directed**.
    b. Output Device: Analog control panel **OR** DDC system alarm, **as directed**.
    c. Action: Signal alarm.
    d. Display: Chiller "failure-to-start" indication.
8. Chilled-Water Level:
    a. Input Device: Expansion tank level switch **OR** liquid sensor, **as directed**.
    b. Output Device: Electric relay signal to alarm panel **OR** DDC system alarm, **as directed**.
    c. Action: Signal alarm.
    d. Display: Expansion tank low-level alarm.
9. Chilled-Water Supply Temperature:
    a. Input Device: Temperature sensor **OR** transmitter, **as directed**, in common chilled-water supply piping.
    b. Output Device: Integral chiller controls **OR** DDC system signal to chiller control panel, **as directed**.
    c. Action: Maintain constant leaving chilled-water temperature reset according to highest cooling demand, **as directed**.
        1) Display: Chilled-water supply temperature.
10. Condenser-Water Temperature:
    a. Input Device: Temperature sensor **OR** transmitter, **as directed**, in cooling-tower sump.
    b. Output Device: Bypass control valve **OR** Cooling-tower fan starter relay **OR** DDC system command to cooling-tower fan starter relay, **as directed**.
    c. Action: Modulate control valve open to cooling tower and closed to bypass and cycle tower fan(s) on and off **OR** and to low speed and then to high speed, **as directed**, to maintain 65 deg F (18 deg C) **OR** 70 deg F (21 deg C), **as directed**, sump temperature. Close valve when unoccupied, **as directed**.
    d. Display:
        1) Condenser-water sump (return) control-point temperature.
        2) Condenser-water sump (return) temperature.
        3) Control-valve position.
        4) Cooling-tower fan(s) on-off indication.
        5) Condenser-water supply temperature.
11. Cooling-Tower Sump Heater:
    a. Input Device: Sump temperature sensor **OR** transmitter, **as directed**.
    b. Output Device: Electric relay **OR** DDC system command to electric relay**,** as directed**,** and solenoid valve, **as directed**.
    c. Action: Energize sump heater; drain sump on low temperature, **as directed**.
    d. Display:
        1) Cooling-tower sump temperature.
        2) Cooling-tower sump heater on-off indication.
        3) Cooling-tower dump indication.
12. Operator Station Display: Indicate the following on operator workstation display terminal:
    a. DDC system graphic.
    b. DDC system status, on-off.
    c. Low-level cooling-tower sump alarm.
    d. Outdoor-air temperature.
    e. Cooling (software) demand indication.
    f. Time and time schedule.

- g. Condenser-water pump(s) on-off status.
- h. Condenser-water pump(s) on-off indication.
- i. Condenser-water flow indication.
- j. Chilled-water pump(s) on-off status.
- k. Chilled-water pump(s) on-off indication.
- l. Cooling-tower fan(s) on-off indication.
- m. Chilled-water flow indication.
- n. Refrigeration machine on-off indication.
- o. Chilled-water supply temperature.
- p. Chilled-water return temperature.
- q. Chilled-water temperature control-point adjustment.
- r. Chiller(s) on-off status.
- s. Chiller(s) on-off indication.
- t. Chiller "failure-to-start" indication.
- u. Expansion tank low-level alarm.
- v. Condenser-water sump (return) control-point temperature.
- w. Condenser-water sump (return) temperature.
- x. Condenser-water control-valve position.
- y. Cooling-tower fan(s) on-off indication.
- z. Condenser-water supply temperature.
- aa. Cooling-tower sump temperature.
- bb. Cooling-tower sump heater on-off indication.
- cc. Cooling-tower dump indication.
- dd. Chilled-water pressure drop through chiller.
- ee. Entering condenser-water temperature.
- ff. Leaving condenser-water temperature.
- gg. Condenser-water pressure drop through chiller.
- hh. Chiller condenser-water supply and return temperature.
- ii. Chiller chilled-water supply and return temperature.
- jj. System capacity in tons.

F. Air-Handling-Unit Control Sequences
- 1. Start and Stop Supply Fan(s):
    - a. Enable: Freeze Protection:
        - 1) Input Device: Duct-mounted averaging element thermostat, located before supply fan.
        - 2) Output Device: Hard wired through motor starter; analog alarm panel **OR** DDC system alarm, **as directed**.
        - 3) Action: Allow start if duct temperature is above 37 deg F (3 deg C); signal alarm if fan fails to start as commanded.
    - b. Enable: High-Temperature Protection:
        - 1) Input Device: Duct-mounted thermostat, located in return air.
        - 2) Output Device: Hard wired through motor starter; analog alarm panel **OR** DDC system alarm, **as directed**.
        - 3) Action: Allow start if duct temperature is below 300 deg F (150 deg C).
    - c. Enable: Smoke Control:
        - 1) Input Device: Duct-mounted smoke detector, located in return **OR** supply, **as directed**, air.
        - 2) Output Device: Hard wired through motor starter; analog alarm panel **OR** DDC system alarm, **as directed**.
        - 3) Action: Allow start if duct is free of products of combustion.
    - d. Initiate: Occupied Time Schedule:
        - 1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        - 2) Output Device: Time clock **OR** Binary output, **as directed**, to motor starter.
        - 3) Action: Energize fan(s).
    - e. Initiate: Unoccupied Time Schedule:

1) Input Device: Room thermostat **OR** DDC system demand, **as directed**.
2) Output Device: Room thermostat **OR** Binary output, **as directed**, to motor starter.
3) Action: Energize fan(s).

f. Unoccupied Ventilation:
1) Input Device: Time clock and room thermostat **OR** DDC system time schedule and output, **as directed**.
2) Output Device: Room thermostat **OR** DDC system binary output, **as directed**, to motor starter.
3) Action: Cycle fan(s) during unoccupied periods.

g. Display: Supply-fan on-off indication.

2. Supply Fan(s) Variable-Volume Control:
   a. Occupied Time Schedule:
      1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
      2) Output Device: Time clock **OR** Binary output, **as directed**.
      3) Action: Enable control.
   b. Volume Control (for fans equipped with variable inlet vanes):
      1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing supply-duct static pressure referenced to conditioned-space static pressure.
      2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator. Set inlet guide vanes to minimum **OR** closed, **as directed**, position when fan is stopped.
      3) Action: Maintain constant supply-duct static pressure.
   c. Volume Control (for fans equipped with variable-speed drives):
      1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing supply-duct static pressure referenced to conditioned-space static pressure.
      2) Output Device: Receiver controller **OR** DDC system analog output, **as directed**, to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
      3) Action: Maintain constant supply-duct static pressure.
   d. High Pressure:
      1) Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
      2) Output Device: Receiver controller **OR** DDC system binary output, **as directed**, to alarm panel **OR** motor starter, **as directed**.
      3) Action: Stop fan and signal alarm when static pressure rises above excessive-static-pressure set point.
   e. Display:
      1) Supply-fan-discharge static-pressure indication.
      2) Supply-fan-discharge static-pressure set point.
      3) Supply-fan airflow rate.
      4) Supply-fan inlet vane position **OR** speed, **as directed**.
3. Start and Stop Return Fan(s):
   a. Initiate: Occupied Time Schedule:
      1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
      2) Output Device: Time clock **OR** Binary output, **as directed**, to motor starter.
      3) Action: Energize fans when supply fans are energized.
   b. Initiate: Unoccupied Time Schedule:
      1) Input Device: Room thermostat **OR** DDC system demand, **as directed**.
      2) Output Device: Room thermostat **OR** Binary output, **as directed**, to motor starter.
      3) Action: Energize fans when supply fans are energized.
   c. Unoccupied Ventilation:
      1) Input Device: Time clock and room thermostat **OR** DDC system time schedule and output, **as directed**.

    2) Output Device: Room thermostat **OR** DDC system binary output, **as directed**, to motor starter.
    3) Action: Cycle fan(s) during unoccupied periods.
  d. Display: Return-fan on-off indication.
4. Return Fan(s) Variable-Volume Control:
  a. Occupied Time Schedule:
    1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
    2) Output Device: Time clock **OR** Binary output, **as directed**.
    3) Action: Enable control.
  b. Volume Control (for fans equipped with variable inlet vanes):
    1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing building static pressure referenced to outdoor static pressure.
    2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator. Set inlet guide vanes to minimum **OR** closed, **as directed**, position when fan is stopped.
    3) Action: Maintain constant building static pressure.
  c. Volume Control (for fans equipped with variable-speed drives):
    1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing building static pressure referenced to outdoor static pressure.
    2) Output Device: Receiver controller **OR** DDC system analog output, **as directed**, to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
    3) Action: Maintain constant building static pressure.
  d. Display:
    1) Return-air static-pressure indication.
    2) Return-air static-pressure set point.
    3) Return-fan airflow rate.
    4) Return-fan inlet vane position **OR** speed, **as directed**.
    5) Building static-pressure indication.
    6) Building static-pressure set point.
5. Return Fan(s) Variable-Volume Control:
  a. Occupied Time Schedule:
    1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
    2) Output Device: Time clock **OR** Binary output, **as directed**.
    3) Action: Enable control.
  b. Volume Control (for fans equipped with variable inlet vanes):
    1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing building static pressure referenced to outdoor static pressure.
    2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator. Set inlet guide vanes to minimum **OR** closed, **as directed**, position when fan is stopped.
    3) Action: Maintain constant building static pressure.
  c. Volume Control (for fans equipped with variable-speed drives):
    1) Input Device: Static-pressure transmitter **OR** Differential-pressure switch, **as directed**, sensing building static pressure referenced to outdoor static pressure.
    2) Output Device: Receiver controller **OR** DDC system analog output, **as directed**, to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
    3) Action: Maintain constant building static pressure.
  d. Display:
    1) Return-fan-discharge static-pressure indication.
    2) Return-fan-discharge static-pressure set point.
    3) Return-fan airflow rate.
    4) Return-fan inlet vane position **OR** speed, **as directed**.

6. Preheat Coil:
    a. Freeze Protection:
        1) Input Device: Duct-mounted averaging element thermostat, located after preheat coil.
        2) Output Device: Hard wired through motor starter; analog alarm panel **OR** DDC system alarm, **as directed**.
        3) Action: Allow start if duct temperature is above 33 deg F (1 deg C).
    b. Occupied Time Schedule:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Time clock **OR** Binary output, **as directed**, to motor starter.
        3) Action: Energize coil circulating pump(s).
    c. Supply **OR** Discharge, **as directed**, -Air Temperature:
        1) Input Device: Time clock and duct-mounted thermostat **OR** DDC system time schedule and electronic temperature sensor, **as directed**.
        2) Output Device: Modulating control valve.
        3) Action: Maintain air temperature set point of 55 deg F (13 deg C).
    d. Unoccupied Time Schedule:
        1) Input Device: Time clock and duct-mounted thermostat mounted in outdoor air **OR** DDC system time schedule and outdoor-air temperature, **as directed**.
        2) Output Device: Time clock **OR** Binary output, **as directed**, to motor starter.
        3) Action: Energize coil circulating pump(s) when outdoor-air temperature falls below 35 deg F (2 deg C).
    e. Display:
        1) Preheat-coil air-temperature indication.
        2) Preheat-coil air-temperature set point.
        3) Preheat-coil pump operation indication.
        4) Preheat-coil control-valve position.
7. Mixed-Air Control:
    a. Occupied Time Schedule:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Pneumatic relay **OR** DDC system output, **as directed**.
        3) Action: Enable control.
    b. Minimum Position:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator(s).
        3) Action: Open minimum outdoor-air dampers **OR** outdoor-air dampers to minimum position, **as directed**.
    c. Heating Reset:
        1) Input Device: Room thermostat **OR** DDC system software, **as directed**.
        2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator(s).
        3) Action: Close minimum outdoor-air dampers **OR** Set outdoor-air dampers to minimum position, **as directed**.
    d. Supply **OR** Mixed, **as directed**, -Air Temperature:
        1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**.
        2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator(s).
        3) Action: Modulate outdoor-, return-, and relief-air dampers to maintain air temperature set point of 55 deg F (13 deg C).
    e. Cooling Reset:
        1) Input Device: Outdoor- and return-air, duct-mounted thermostats **OR** electronic temperature sensors, **as directed**.

        2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to damper actuator(s).
        3) Action: Set outdoor-air dampers to minimum position when outdoor-air temperature exceeds return-air temperature **OR** enthalpy exceeds return-air enthalpy, **as directed**.
    f. Unoccupied Time Schedule:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, to modulating damper actuator(s).
        3) Action: Position outdoor- and relief-air dampers closed and return-air dampers open.
    g. Display:
        1) Mixed-air-temperature indication.
        2) Mixed-air-temperature set point.
        3) Mixed-air damper position.
8. Humidifier:
    a. Occupied Time Schedule:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**, and airflow switch
        2) Output Device: Pneumatic relay **OR** DDC system output, **as directed**.
        3) Action: Enable control.
    b. Humidity:
        1) Input Device: Room humidistat **OR** Return-air, duct-mounted humidistat **OR** DDC system, **as directed**.
        2) Output Device: Receiver controller **OR** DDC system analog output **OR** DDC system analog output to digital-to-pneumatic transducer, **as directed**, enables humidifier **OR** modulates control valve to maintain humidity **OR** cycles pump to maintain humidity **OR** cycles pump and modulates control valve to maintain humidity, **as directed**, in straight-line relationship for the following conditions:
            a) 20 percent when outdoor-air temperature is minus 30 deg F (minus 35 deg C).
            b) 40 percent when outdoor-air temperature is 75 deg F (24 deg C).
        3) Action: Modulate outdoor-, return-, and relief-air dampers to maintain air temperature set point of 55 deg F (13 deg C).
    c. Display:
        1) Relative humidity indication.
        2) Relative humidity set point.
        3) Relative humidity control-valve position.
9. Filters: During occupied periods, when fan is running, differential air-pressure transmitters exist.
    a. Occupied Time Schedule:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Electric relay **OR** DDC system output, **as directed**.
        3) Action: Enable control.
    b. Differential Pressure:
        1) Input Device: Differential-pressure switches **OR** Pressure transmitter, **as directed**.
        2) Output Device: Analog alarm panel **OR** DDC system alarm, **as directed**.
        3) Action: Signal alarm on low- and high-pressure conditions.
    c. Display:
        1) Filter air-pressure-drop indication.
        2) Filter low-air-pressure set point.
        3) Filter high-air-pressure set point.
10. Hydronic **OR** Steam, **as directed**, Heating Coil:
    a. Occupied Time Schedule:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Time clock **OR** Binary output, **as directed**.

3) Action: Enable control.

b. Supply **OR** Discharge, **as directed**, -Air Temperature:
   1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**.
   2) Output Device: Normally open **OR** closed, **as directed**, modulating control valve.
   3) Action: Maintain supply-air temperature set point of 55 deg F (13 deg C).

c. Temperature Reset (for constant-temperature supply-air systems):
   1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**, in return air.
   2) Output Device: Direct to receiver controller **OR** DDC system, **as directed**, in straight-line relationship for the following conditions:
      a) 65 deg F (18 deg C) when return-air temperature is 70 deg F (21 deg C).
      b) 55 deg F (13 deg C) when return-air temperature is 75 deg F (24 deg C).
   3) Action: Reset supply-air temperature set point of 55 deg F (13 deg C).

d. Temperature Reset (for multizone or dual-duct supply-air systems):
   1) Input Device: Load analyzer **OR** DDC system, **as directed**, with input from room thermostats **OR** temperature sensors, **as directed**.
   2) Output Device: Direct to receiver controller **OR** DDC system, **as directed**.
   3) Action: Reset supply-air temperature in response to greatest heating demand.

e. Unoccupied Time Schedule:
   1) Input Device: Time clock and room thermostat **OR** DDC system time schedule and output, **as directed**.
   2) Output Device: Room thermostat (cycling fan) **OR** DDC system binary output, **as directed**.
   3) Action: Enable normal control **OR** Return valve to normal position, **as directed**, when fan is cycled on.

f. Display:
   1) Fan-discharge air-temperature indication.
   2) Fan-discharge air-temperature set point.
   3) Heating-coil air-temperature indication.
   4) Heating-coil air-temperature set point.
   5) Heating-coil pump operation indication.
   6) Heating-coil control-valve position.
   7) Hot-deck air-temperature indication.
   8) Hot-deck air-temperature set point.

11. Hydronic Cooling Coil:

a. Occupied Time Schedule:
   1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
   2) Output Device: Time clock **OR** Binary output, **as directed**.
   3) Action: Enable control.

b. Supply **OR** Discharge, **as directed**, -Air Temperature:
   1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**.
   2) Output Device: Normally open **OR** closed, **as directed**, modulating control valve.
   3) Action: Maintain supply-air temperature set point of 55 deg F (13 deg C).

c. Temperature Reset (for constant-temperature systems):
   1) Input Device: Duct-mounted thermostat **OR** Electronic temperature sensor, **as directed**, in return air.
   2) Output Device: Direct to receiver controller **OR** DDC system, **as directed**, in straight-line relationship for the following conditions:
      a) 65 deg F (18 deg C) when return-air temperature is 70 deg F (21 deg C).
      b) 55 deg F (13 deg C) when return-air temperature is 75 deg F (24 deg C).
   3) Action: Reset supply-air temperature set point of 55 deg F (13 deg C).

d. Temperature Reset (for multizone or dual-duct supply-air systems):
   1) Input Device: Load analyzer **OR** DDC system, **as directed**, with input from room thermostats **OR** temperature sensors, **as directed**.
   2) Output Device: Direct to receiver controller **OR** DDC system, **as directed**.

        3) Action: Reset supply-air temperature in response to greatest heating demand.
    e. Unoccupied Time Schedule:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Time clock **OR** Binary output, **as directed**.
        3) Action: Disable control.
    f. Display:
        1) Fan-discharge air-temperature indication.
        2) Fan-discharge air-temperature set point.
        3) Cooling-coil air-temperature indication.
        4) Cooling-coil air-temperature set point.
        5) Cooling-coil control-valve position.
        6) Cold-deck air-temperature indication.
        7) Cold-deck air-temperature set point.

12. Multizone Damper Control:
    a. Occupied Time Schedule:
        1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Time clock **OR** Binary output, **as directed**.
        3) Action: Enable control.
    b. Room Temperature:
        1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
        2) Output Device: Damper actuator.
        3) Action: Maintain room temperature.
    c. Display:
        1) Room temperature indication.
        2) Room temperature set point.
        3) Multizone damper position.
13. Coordination of Air-Handling Unit Sequences: Ensure that preheat, mixed-air, heating-coil, and cooling-coil controls have common inputs and do not overlap in function.
14. Operator Station Display: Indicate the following on operator workstation display terminal:
    a. DDC system graphic.
    b. DDC system on-off indication.
    c. DDC system occupied/unoccupied mode.
    d. Outdoor-air-temperature indication.
    e. Supply-fan on-off indication.
    f. Supply-fan-discharge static-pressure indication.
    g. Supply-fan-discharge static-pressure set point.
    h. Supply-fan airflow rate.
    i. Supply-fan inlet vane position **OR** speed, **as directed**.
    j. Return-fan on-off indication.
    k. Return-air static-pressure indication.
    l. Return-air static-pressure set point.
    m. Return-fan airflow rate.
    n. Return-fan inlet vane position **OR** speed, **as directed**.
    o. Building static-pressure indication.
    p. Building static-pressure set point.
    q. Preheat-coil air-temperature indication.
    r. Preheat-coil air-temperature set point.
    s. Preheat-coil pump operation indication.
    t. Preheat-coil control-valve position.
    u. Mixed-air-temperature indication.
    v. Mixed-air-temperature set point.
    w. Mixed-air damper position.
    x. Relative humidity indication.
    y. Relative humidity set point.
    z. Relative humidity control-valve position.
    aa. Filter air-pressure-drop indication.

bb. Filter low-air-pressure set point.
cc. Filter high-air-pressure set point.
dd. Fan-discharge air-temperature indication.
ee. Fan-discharge air-temperature set point.
ff. Heating-coil air-temperature indication.
gg. Heating-coil air-temperature set point.
hh. Heating-coil pump operation indication.
ii. Heating-coil control-valve position.
jj. Hot-deck air-temperature indication.
kk. Hot-deck air-temperature set point.
ll. Cooling-coil air-temperature indication.
mm. Cooling-coil air-temperature set point.
nn. Cooling-coil control-valve position.
oo. Cold-deck air-temperature indication.
pp. Cold-deck air-temperature set point.
qq. Room temperature indication.
rr. Room temperature set point.
ss. Multizone damper position.

G. Terminal Unit Operating Sequence
1. Cabinet Unit Heater, Hydronic **OR** Steam, **as directed**:
    a. Room Temperature:
        1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
        2) Output Device: Room thermostat **OR** DDC system binary output, **as directed**.
        3) Action: Cycle fan to maintain temperature.
    b. Low-Temperature Safety:
        1) Input Device: Line-voltage, on-off thermostat, pipe mounted.
        2) Output Device: Hard wired.
        3) Action: Stop fan when return heating-water **OR** condensate, **as directed**, temperature falls below 35 deg F (2 deg C).
    c. Display:
        1) Room temperature indication.
        2) Room temperature set point.
2. Cabinet Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
3. Unit Heater, Hydronic **OR** Steam, **as directed**:
    a. Room Temperature:
        1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
        2) Output Device: Room thermostat **OR** DDC system binary output, **as directed**.
        3) Action: Cycle fan to maintain temperature.
    b. Low-Temperature Safety:
        1) Input Device: Line-voltage, on-off thermostat, pipe mounted.
        2) Output Device: Hard wired.
        3) Action: Stop fan when return heating-water **OR** condensate, **as directed**, temperature falls below 35 deg F (2 deg C).
    c. Display:
        1) Room temperature indication.
        2) Room temperature set point.
4. Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
5. Combustion-Air Unit Heaters:
    a. Room Temperature:
        1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
        2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operator.
        3) Action: Modulate valve to maintain temperature.
    b. Display:
        1) Room temperature indication.
        2) Room temperature set point.
        3) Control-valve position.

6. Radiant Heating Cable, Electric: Room thermostat cycles power.
7. Radiant Heating Panel, Electric: Room thermostat cycles power.
8. Radiant Heating Panel, Hydronic:
    a. Room Temperature:
        1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
        2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operator.
        3) Action: Modulate valve to maintain temperature.
    b. Display:
        1) Room temperature indication.
        2) Room temperature set point.
        3) Control-valve position.
9. Two-Pipe, Single-Coil, Fan-Coil Unit:
    a. Occupied Time Schedule:
        1) Input Device: Fan switch **OR** Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Time clock **OR** Binary output, **as directed**.
        3) Action: Start and stop fan and enable control.
    b. Room Temperature:
        1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**, in room **OR** return air, **as directed**.
        2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operator.
        3) Action: Modulate valve to maintain temperature.
    c. DDC System Changeover:
        1) Input Device: Thermostat **OR** Electronic temperature sensor, **as directed**, in supply-water **OR** on supply-water piping **OR** DDC system, **as directed**.
        2) Output Device: Hard-wired relay **OR** DDC system software, **as directed**.
        3) Action: Reverse control-valve action to switch from heating to cooling.
    d. Display:
        1) DDC system graphic.
        2) DDC system on-off indication.
        3) DDC system occupied/unoccupied mode.
        4) Room temperature indication.
        5) Room temperature set point.
        6) Control-valve position.
        7) Supply-water temperature indication.
10. Four-Pipe, Hydronic Fan-Coil Unit:
    a. Occupied Time Schedule:
        1) Input Device: Fan switch **OR** Time clock **OR** DDC system time schedule, **as directed**.
        2) Output Device: Time clock **OR** Binary output, **as directed**.
        3) Action: Start and stop fan and enable control.
    b. Room Temperature:
        1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
        2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operators.
        3) Action: Modulate multiport control valves to maintain temperature.
    c. Display:
        1) DDC system graphic.
        2) DDC system on-off indication.
        3) DDC system occupied/unoccupied mode.
        4) Room temperature indication.
        5) Room temperature set point.
        6) Control-valve position.
11. Unit Ventilator: Room thermostat modulates heating-and-cooling control valves; airstream thermostats modulate outdoor- and return-air dampers as follows:
    a. Occupied Time Schedule:

1) Input Device: Fan switch **OR** Time clock **OR** DDC system time schedule, **as directed**.
2) Output Device: Time clock **OR** Binary output, **as directed**.
3) Action: Start and stop fan, move outdoor- and return-air dampers to minimum **OR** maximum, **as directed**, outdoor-air position, and enable control.

b. Room Temperature - Valves:
   1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
   2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operators.
   3) Action: Modulate heating-water supply control valve and chilled-water supply control valve in sequence to maintain temperature.

c. Room Temperature - Dampers:
   1) Input Device: Thermostat **OR** Electronic temperature sensor, **as directed**, in mixed air.
   2) Output Device: Pneumatic **OR** Electronic, **as directed**, control damper actuators.
   3) Action: Modulate outdoor- and return-air dampers to maintain temperature.

d. Supply-Air Temperature Limit:
   1) Input Device: Thermostat **OR** Electronic temperature sensor, **as directed**, in discharge air.
   2) Output Device: Pneumatic **OR** Electronic, **as directed**, control-valve operators and control damper actuators.
   3) Action: Override room thermostat to control valves and dampers to prevent discharge air from dropping below a minimum set point.

e. Warm-up Cycle:
   1) Input Device: Time clock **OR** DDC system time schedule, **as directed**.
   2) Output Device: Hard-wired relay **OR** DDC system binary output, **as directed**.
   3) Action: Open heating-water supply control valve, close outdoor-air damper, and open return-air damper.

f. Display:
   1) DDC system graphic.
   2) DDC system on-off indication.
   3) DDC system occupied/unoccupied mode.
   4) Room temperature indication.
   5) Room temperature set point.
   6) Control-valve position.
   7) Damper position.

12. Heating Coils, Hydronic **OR** Steam, **as directed**:
    a. Room Temperature:
       1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
       2) Output Device: Pneumatic **OR** Electronic **OR** Electric, **as directed**, control-valve operators.
       3) Action: Modulate **OR** Cycle, **as directed**, valve to maintain temperature.
    b. Display:
       1) Room temperature indication.
       2) Room temperature set point.
       3) Control-valve position.

13. Heating Coils, Electric: Room thermostat cycles coils **OR** sequences stages of heating, **as directed**.

14. Radiators and Convectors, Hydronic **OR** Steam, **as directed**:
    a. Occupancy:
       1) Input Device: Occupancy sensor.
       2) Output Device: DDC system binary output.
       3) Action: Report occupancy and enable occupied temperature set point.
    b. Room Temperature:
       1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
       2) Output Device: Pneumatic **OR** Electronic **OR** Electric, **as directed**, control-valve operators.
       3) Action: Modulate **OR** Cycle, **as directed**, valve to maintain temperature.

      - a) Occupied Temperature: 75 deg F (24 deg C).
      - b) Unoccupied Temperature: 65 deg F (18 deg C).
  - c. Display:
    - 1) Room/area served.
    - 2) Room temperature indication.
    - 3) Room temperature set point.
    - 4) Room temperature set point, occupied.
    - 5) Room temperature set point, occupied standby.
    - 6) Room temperature set point, unoccupied.
    - 7) Control-valve position as percent open.
- 15. Radiators and Convectors, Electric: Room thermostat cycles coils **OR** sequences stages of heating, **as directed**.
- 16. Constant-Volume, Terminal Air Units, Hydronic **OR** Steam, **as directed**:
  - a. Occupancy:
    - 1) Input Device: Occupancy sensor.
    - 2) Output Device: DDC system binary output.
    - 3) Action: Report occupancy and enable occupied temperature set point.
      - a) Occupied Temperature: 75 deg F (24 deg C).
      - b) Unoccupied Temperature: 65 deg F (18 deg C).
  - b. Room Temperature:
    - 1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
    - 2) Output Device: Pneumatic **OR** Electronic **OR** Electric, **as directed**, control-valve operators.
    - 3) Action: Modulate **OR** Cycle, **as directed**, valve to maintain temperature.
  - c. Display:
    - 1) Room/area served.
    - 2) Room occupied/unoccupied.
    - 3) Room temperature indication.
    - 4) Room temperature set point.
    - 5) Room temperature set point, occupied.
    - 6) Room temperature set point, unoccupied.
    - 7) Control-valve position as percent open.
- 17. VAV, Terminal Air Units with Hydronic **OR** Steam, **as directed**, Coils:
  - a. Occupancy:
    - 1) Input Device: Occupancy sensor.
    - 2) Output Device: DDC system binary output.
    - 3) Action: Report occupancy and enable occupied temperature set point.
      - a) Occupied Temperature: 75 deg F (24 deg C).
      - b) Unoccupied Temperature: 65 deg F (18 deg C).
  - b. Room Temperature:
    - 1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
    - 2) Output Device: Pneumatic **OR** Electronic, **as directed**, damper actuators and control-valve operators.
    - 3) Action: Modulate damper and valve to maintain temperature.
      - a) Sequence damper from full open to minimum position, then valve from closed to fully open.
  - c. Display:
    - 1) Room/area served.
    - 2) Room occupied/unoccupied.
    - 3) Room temperature indication.
    - 4) Room temperature set point.
    - 5) Room temperature set point, occupied.
    - 6) Room temperature set point, unoccupied.
    - 7) Air-damper position as percent open.
    - 8) Control-valve position as percent open.
- 18. Dual-Duct, VAV, Terminal Air Units:

- a. Occupancy:
  - 1) Input Device: Occupancy sensor.
  - 2) Output Device: DDC system binary output.
  - 3) Action: Report occupancy and enable occupied temperature set point.
    - a) Occupied Temperature: 75 deg F (24 deg C).
    - b) Unoccupied Temperature: 65 deg F (18 deg C).
- b. Room Temperature:
  - 1) Input Device: Room thermostat **OR** Electronic temperature sensor, **as directed**.
  - 2) Output Device: Pneumatic **OR** Electronic, **as directed**, damper actuators.
  - 3) Action: Modulate dampers to maintain temperature.
    - a) Sequence when space temperature is below set point: Close VAV damper to minimum position, open hot-deck dampers and close cold-deck dampers, then open VAV damper.
    - b) Sequence when space temperature is above set point: Close VAV damper to minimum position, close hot-deck dampers and open cold-deck dampers, then open VAV damper.
- c. Display:
  - 1) Room/area served.
  - 2) Room occupied/unoccupied.
  - 3) Room temperature indication.
  - 4) Room temperature set point.
  - 5) Room temperature set point, occupied.
  - 6) Room temperature set point, unoccupied.
  - 7) VAV damper position as percent open.
  - 8) Hot-deck damper position as percent open.
  - 9) Cold-deck damper position as percent open.

H. Ventilation Sequences

1. Combustion-Air, Makeup Unit Control, Electric: Start fan when served appliance burner starts; room thermostat sequences stages of heating.
2. Combustion-Air, Makeup Unit Control, Hydronic **OR** Steam, **as directed**: Start fan when served appliance burner starts; room thermostat cycles **OR** modulates, **as directed**, control valve.
3. Gravity Roof Ventilator: Occupancy sensor **OR** Room thermostat, **as directed**, opens dampers.
4. Exhaust Fan: Occupancy sensor **OR** Interlock with light switch **OR** Room thermostat, **as directed**, cycles fan.
5. Kitchen Exhaust Fan: Occupancy sensor starts fan and energizes makeup air unit.

1.2 PRODUCTS (Not Applicable)

1.3 EXECUTION (Not Applicable)

END OF SECTION 23 01 10 00

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SECTION 23 01 10 00a - TESTING, ADJUSTING, AND BALANCING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for testing, adjusting and balancing. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section Includes:
      a. Balancing Air Systems:
         1) Constant-volume air systems.
         2) Dual-duct systems.
         3) Variable-air-volume systems.
         4) Multizone systems.
         5) Induction-unit systems.
      b. Balancing Hydronic Piping Systems:
         1) Constant-flow hydronic systems.
         2) Variable-flow hydronic systems.
         3) Primary-secondary hydronic systems.

C. Definitions
   1. AABC: Associated Air Balance Council.
   2. NEBB: National Environmental Balancing Bureau.
   3. TAB: Testing, adjusting, and balancing.
   4. TABB: Testing, Adjusting, and Balancing Bureau.
   5. TAB Specialist: An entity engaged to perform TAB Work.

D. Submittals
   1. LEED Submittal:
      a. Air-Balance Report for LEED Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2, "Air Balancing."
   2. Strategies and Procedures Plan: Within 30 **OR** 60 **OR** 90, **as directed**, days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
   3. Certified TAB reports.

E. Quality Assurance
   1. TAB Contractor Qualifications: Engage a TAB entity certified by AABC **OR** NEBB **OR** TABB, **as directed**.
      a. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC **OR** NEBB **OR** TABB, **as directed**.
      b. TAB Technician: Employee of the TAB contractor and who is certified by AABC **OR** NEBB **OR** TABB, **as directed**, as a TAB technician.
   2. Certify TAB field data reports and perform the following:
      a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
      b. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
   3. TAB Report Forms: Use standard TAB contractor's forms approved by The University **OR** Owner **OR** Commissioning Authority, **as directed**.
   4. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

5. Demonstrate relevant experience (firm or personnel) by providing a list of projects of similar spaces and system types. (e.g. clinical, medical, dental, lab spaces; dual duct systems, lab exhaust systems)

F. Project Conditions
   1. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
      OR
      Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.2 PRODUCTS (Not Applicable)

1.3 EXECUTION

A. Examination
   1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   2. Examine systems for installed balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
   3. Examine the approved submittals for HVAC systems and equipment.
   4. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
   5. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section(s) "Metal Ducts" OR "Nonmetal Ducts", **as directed**, and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
   6. Examine equipment performance data including fan and pump curves.
      a. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
      b. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
   7. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
   8. Examine test reports specified in individual system and equipment Sections.
   9. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
   10. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
   11. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
   12. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
   13. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
   14. Examine system pumps to ensure absence of entrained air in the suction piping.
   15. Examine operating safety interlocks and controls on HVAC equipment.

16. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

B. Preparation
1. Prepare a TAB plan that includes strategies and step-by-step procedures.
2. Complete system-readiness checks and prepare reports. Verify the following:
    a. Permanent electrical-power wiring is complete.
    b. Hydronic systems are filled, clean, and free of air.
    c. Automatic temperature-control systems are operational.
    d. Equipment and duct access doors are securely closed.
    e. Balance, smoke, and fire dampers are open.
    f. Isolating and balancing valves are open and control valves are operational.
    g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
    h. Windows and doors can be closed so indicated conditions for system operations can be met.

C. General Procedures For Testing And Balancing
1. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" **OR** ASHRAE 111 **OR** NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" **OR** SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", **as directed**, and in this Section.
    a. Comply with requirements in ASHRAE 62.1, Section 7.2.2, "Air Balancing."
2. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
    a. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
    OR
    After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories".
    b. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "Hvac Insulation".
3. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
4. Take and report testing and balancing measurements in inch-pound (IP) **OR** metric (SI) **OR** inch-pound (IP) and metric (SI), **as directed,** units.

D. General Procedures For Balancing Air Systems
1. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
2. Prepare schematic diagrams of systems' "as-built" duct layouts.
3. For variable-air-volume systems, develop a plan to simulate diversity.
4. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
5. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
6. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
7. Verify that motor starters are equipped with properly sized thermal protection.
8. Check dampers for proper position to achieve desired airflow path.
9. Check for airflow blockages.
10. Check condensate drains for proper connections and functioning.
11. Check for proper sealing of air-handling-unit components.
12. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts".

E. Procedures For Constant-Volume Air Systems
  1. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
    a. Measure total airflow.
      1) Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
    b. Measure fan static pressures as follows to determine actual static pressure:
      1) Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
      2) Measure static pressure directly at the fan outlet or through the flexible connection.
      3) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
      4) Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
    c. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      1) Report the cleanliness status of filters and the time static pressures are measured.
    d. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
    e. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
    f. Obtain approval from The University **OR** Owner **OR** Commissioning Authority, **as directed**, for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 21 for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
    g. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
  2. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
    a. Measure airflow of submain and branch ducts.
      1) Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
    b. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
    c. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
  3. Measure air outlets and inlets without making adjustments.
    a. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
  4. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
    a. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
    b. Adjust patterns of adjustable outlets for proper distribution without drafts.

F. Procedures For Dual-Duct Systems
  1. Verify that the cooling coil is capable of full-system airflow, and set mixing boxes at full-cold airflow position for fan volume.

2. Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.
    a. If insufficient static pressure exists, increase airflow at the fan.
3. Test and adjust the constant-volume mixing boxes as follows:
    a. Verify both hot and cold operations by adjusting the thermostat and observing changes in air temperature and volume.
    b. Verify sufficient inlet static pressure before making volume adjustments.
    c. Adjust mixing boxes to indicated airflows within specified tolerances. Measure airflow by Pitot-tube traverse readings or by measuring static pressure at mixing-box taps if provided by mixing-box manufacturer.
4. Do not overpressurize ducts.
5. Remeasure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.
6. Adjust variable-air-volume, dual-duct systems in the same way as constant-volume, dual-duct systems; adjust maximum- and minimum-airflow setting of each mixing box.

G. Procedures For Variable-Air-Volume Systems
1. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
2. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
    a. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
    b. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
    c. Measure total system airflow. Adjust to within indicated airflow.
    d. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
    e. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
        1) If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
    f. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
        1) Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
    g. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
    h. Record final fan-performance data.
3. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
    a. Balance variable-air-volume systems the same as described for constant-volume air systems.
    b. Set terminal units and supply fan at full-airflow condition.

c. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
d. Readjust fan airflow for final maximum readings.
e. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
f. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
g. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    1) If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
h. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    1) Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

4. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
    a. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
    b. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
    c. Set terminal units at full-airflow condition.
    d. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
    e. Adjust terminal units for minimum airflow.
    f. Measure static pressure at the sensor.
    g. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

H. Procedures For Multizone Systems
1. Set unit at maximum airflow through the cooling coil.
2. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

I. Procedures For Induction-Unit Systems
1. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.
2. Adjust each induction unit.

J. General Procedures For Hydronic Systems
1. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
2. Prepare schematic diagrams of systems' "as-built" piping layouts.
3. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
    a. Open all manual valves for maximum flow.
    b. Check liquid level in expansion tank.
    c. Check makeup water-station pressure gauge for adequate pressure for highest vent.
    d. Check flow-control valves for specified sequence of operation and set at indicated flow.

    e. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
    f. Set system controls so automatic valves are wide open to heat exchangers.
    g. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
    h. Check air vents for a forceful liquid flow exiting from vents when manually operated.

K. Procedures For Constant-Flow Hydronic Systems
  1. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
    a. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gauge heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      1) If impeller sizes must be adjusted to achieve pump performance, obtain approval from The University **OR** Owner **OR** Commissioning Authority, **as directed**, and comply with requirements in Division 23 Section "Hydronic Pumps".
    b. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
      1) Monitor motor performance during procedures and do not operate motors in overload conditions.
    c. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
    d. Report flow rates that are not within plus or minus 10 percent of design.
  2. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
  3. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
  4. Set calibrated balancing valves, if installed, at calculated presettings.
  5. Measure flow at all stations and adjust, where necessary, to obtain first balance.
    a. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
  6. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
  7. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
    a. Determine the balancing station with the highest percentage over indicated flow.
    b. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
    c. Record settings and mark balancing devices.
  8. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
  9. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
  10. Check settings and operation of each safety valve. Record settings.

L. Procedures For Variable-Flow Hydronic Systems
  1. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

M. Procedures For Primary-Secondary Hydronic Systems
  1. Balance the primary circuit flow first and then balance the secondary circuits.

N. Procedures For Steam Systems
  1. Measure and record upstream and downstream pressure of each piece of equipment.

2. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
3. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
4. Check settings and operation of each safety valve. Record settings.
5. Verify the operation of each steam trap.

O. Procedures For Heat Exchangers
1. Measure water flow through all circuits.
2. Adjust water flow to within specified tolerances.
3. Measure inlet and outlet water temperatures.
4. Measure inlet steam pressure.
5. Check settings and operation of safety and relief valves. Record settings.

P. Procedures For Motors
1. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
    a. Manufacturer's name, model number, and serial number.
    b. Motor horsepower rating.
    c. Motor rpm.
    d. Efficiency rating.
    e. Nameplate and measured voltage, each phase.
    f. Nameplate and measured amperage, each phase.
    g. Starter thermal-protection-element rating.
2. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

Q. Procedures For Chillers
1. Balance water flow through each evaporator and condenser, **as directed**, to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
    a. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
    b. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
    c. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
    d. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
    e. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
    f. Capacity: Calculate in tons of cooling.
    g. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

R. Procedures For Cooling Towers
1. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:
    a. Measure condenser-water flow to each cell of the cooling tower.
    b. Measure entering- and leaving-water temperatures.
    c. Measure wet- and dry-bulb temperatures of entering air.
    d. Measure wet- and dry-bulb temperatures of leaving air.
    e. Measure condenser-water flow rate recirculating through the cooling tower.
    f. Measure cooling-tower spray pump discharge pressure.
    g. Adjust water level and feed rate of makeup water system.
    h. Measure flow through bypass.

S. Procedures For Condensing Units
  1. Verify proper rotation of fans.
  2. Measure entering- and leaving-air temperatures.
  3. Record compressor data.

T. Procedures For Boilers
  1. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.
  2. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

U. Procedures For Heat-Transfer Coils
  1. Measure, adjust, and record the following data for each water coil:
     a. Entering- and leaving-water temperature.
     b. Water flow rate.
     c. Water pressure drop.
     d. Dry-bulb temperature of entering and leaving air.
     e. Wet-bulb temperature of entering and leaving air for cooling coils.
     f. Airflow.
     g. Air pressure drop.
  2. Measure, adjust, and record the following data for each electric heating coil:
     a. Nameplate data.
     b. Airflow.
     c. Entering- and leaving-air temperature at full load.
     d. Voltage and amperage input of each phase at full load and at each incremental stage.
     e. Calculated kilowatt at full load.
     f. Fuse or circuit-breaker rating for overload protection.
  3. Measure, adjust, and record the following data for each steam coil:
     a. Dry-bulb temperature of entering and leaving air.
     b. Airflow.
     c. Air pressure drop.
     d. Inlet steam pressure.
  4. Measure, adjust, and record the following data for each refrigerant coil:
     a. Dry-bulb temperature of entering and leaving air.
     b. Wet-bulb temperature of entering and leaving air.
     c. Airflow.
     d. Air pressure drop.
     e. Refrigerant suction pressure and temperature.

V. Procedures For Testing, Adjusting, And Balancing Existing Systems
  1. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
     a. Measure and record the operating speed, airflow, and static pressure of each fan.
     b. Measure motor voltage and amperage. Compare the values to motor nameplate information.
     c. Check the refrigerant charge.
     d. Check the condition of filters.
     e. Check the condition of coils.
     f. Check the operation of the drain pan and condensate-drain trap.
     g. Check bearings and other lubricated parts for proper lubrication.
     h. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
  2. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
     a. New filters are installed.
     b. Coils are clean and fins combed.
     c. Drain pans are clean.
     d. Fans are clean.

  - e. Bearings and other parts are properly lubricated.
  - f. Deficiencies noted in the preconstruction report are corrected.
3. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
  - a. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
  - b. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
  - c. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
  - d. Balance each air outlet.

W. Tolerances

Set HVAC system's air flow rates and water flow rates within the following tolerances:
  - a. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  - b. Air Outlets and Inlets: Plus or minus 10 percent.
  - c. Heating-Water Flow Rate: Plus or minus 10 percent.
  - d. Cooling-Water Flow Rate: Plus or minus 10 percent.

X. Reporting
1. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
2. Status Reports: Prepare weekly **OR** biweekly **OR** monthly, **as directed**, progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

Y. Final Report
1. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - a. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - b. Include a list of instruments used for procedures, along with proof of calibration.
2. Final Report Contents: In addition to certified field-report data, include the following:
  - a. Pump curves.
  - b. Fan curves.
  - c. Manufacturers' test data.
  - d. Field test reports prepared by system and equipment installers.
  - e. Other information relative to equipment performance; do not include Shop Drawings and product data.
3. General Report Data: In addition to form titles and entries, include the following data:
  - a. Title page.
  - b. Name and address of the TAB contractor.
  - c. Project name.
  - d. Project location.
  - e. Architect's name and address.
  - f. Engineer's name and address.
  - g. Contractor's name and address.
  - h. Report date.
  - i. Signature of TAB supervisor who certifies the report.

j. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
k. Summary of contents including the following:
    1) Indicated versus final performance.
    2) Notable characteristics of systems.
    3) Description of system operation sequence if it varies from the Contract Documents.
l. Nomenclature sheets for each item of equipment.
m. Data for terminal units, including manufacturer's name, type, size, and fittings.
n. Notes to explain why certain final data in the body of reports vary from indicated values.
o. Test conditions for fans and pump performance forms including the following:
    1) Settings for outdoor-, return-, and exhaust-air dampers.
    2) Conditions of filters.
    3) Cooling coil, wet- and dry-bulb conditions.
    4) Face and bypass damper settings at coils.
    5) Fan drive settings including settings and percentage of maximum pitch diameter.
    6) Inlet vane settings for variable-air-volume systems.
    7) Settings for supply-air, static-pressure controller.
    8) Other system operating conditions that affect performance.

4. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
    a. Quantities of outdoor, supply, return, and exhaust airflows.
    b. Water and steam flow rates.
    c. Duct, outlet, and inlet sizes.
    d. Pipe and valve sizes and locations.
    e. Terminal units.
    f. Balancing stations.
    g. Position of balancing devices.
5. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
    a. Unit Data:
        1) Unit identification.
        2) Location.
        3) Make and type.
        4) Model number and unit size.
        5) Manufacturer's serial number.
        6) Unit arrangement and class.
        7) Discharge arrangement.
        8) Sheave make, size in inches (mm), and bore.
        9) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
        10) Number, make, and size of belts.
        11) Number, type, and size of filters.
    b. Motor Data:
        1) Motor make, and frame type and size.
        2) Horsepower and rpm.
        3) Volts, phase, and hertz.
        4) Full-load amperage and service factor.
        5) Sheave make, size in inches (mm), and bore.
        6) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
    c. Test Data (Indicated and Actual Values):
        1) Total air flow rate in cfm (L/s).
        2) Total system static pressure in inches wg (Pa).
        3) Fan rpm.
        4) Discharge static pressure in inches wg (Pa).
        5) Filter static-pressure differential in inches wg (Pa).
        6) Preheat-coil static-pressure differential in inches wg (Pa).
        7) Cooling-coil static-pressure differential in inches wg (Pa).
        8) Heating-coil static-pressure differential in inches wg (Pa).
        9) Outdoor airflow in cfm (L/s).

        10) Return airflow in cfm (L/s).
        11) Outdoor-air damper position.
        12) Return-air damper position.
        13) Vortex damper position.
6. Apparatus-Coil Test Reports:
    a. Coil Data:
        1) System identification.
        2) Location.
        3) Coil type.
        4) Number of rows.
        5) Fin spacing in fins per inch (mm) o.c.
        6) Make and model number.
        7) Face area in sq. ft. (sq. m).
        8) Tube size in NPS (DN).
        9) Tube and fin materials.
        10) Circuiting arrangement.
    b. Test Data (Indicated and Actual Values):
        1) Air flow rate in cfm (L/s).
        2) Average face velocity in fpm (m/s).
        3) Air pressure drop in inches wg (Pa).
        4) Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
        5) Return-air, wet- and dry-bulb temperatures in deg F (deg C).
        6) Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
        7) Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
        8) Water flow rate in gpm (L/s).
        9) Water pressure differential in feet of head or psig (kPa).
        10) Entering-water temperature in deg F (deg C).
        11) Leaving-water temperature in deg F (deg C).
        12) Refrigerant expansion valve and refrigerant types.
        13) Refrigerant suction pressure in psig (kPa).
        14) Refrigerant suction temperature in deg F (deg C).
        15) Inlet steam pressure in psig (kPa).
7. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
    a. Unit Data:
        1) System identification.
        2) Location.
        3) Make and type.
        4) Model number and unit size.
        5) Manufacturer's serial number.
        6) Fuel type in input data.
        7) Output capacity in Btu/h (kW).
        8) Ignition type.
        9) Burner-control types.
        10) Motor horsepower and rpm.
        11) Motor volts, phase, and hertz.
        12) Motor full-load amperage and service factor.
        13) Sheave make, size in inches (mm), and bore.
        14) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
    b. Test Data (Indicated and Actual Values):
        1) Total air flow rate in cfm (L/s).
        2) Entering-air temperature in deg F (deg C).
        3) Leaving-air temperature in deg F (deg C).
        4) Air temperature differential in deg F (deg C).
        5) Entering-air static pressure in inches wg (Pa).
        6) Leaving-air static pressure in inches wg (Pa).

        7) Air static-pressure differential in inches wg (Pa).
        8) Low-fire fuel input in Btu/h (kW).
        9) High-fire fuel input in Btu/h (kW).
        10) Manifold pressure in psig (kPa).
        11) High-temperature-limit setting in deg F (deg C).
        12) Operating set point in Btu/h (kW).
        13) Motor voltage at each connection.
        14) Motor amperage for each phase.
        15) Heating value of fuel in Btu/h (kW).

8. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
    a. Unit Data:
        1) System identification.
        2) Location.
        3) Coil identification.
        4) Capacity in Btu/h (kW).
        5) Number of stages.
        6) Connected volts, phase, and hertz.
        7) Rated amperage.
        8) Air flow rate in cfm (L/s).
        9) Face area in sq. ft. (sq. m).
        10) Minimum face velocity in fpm (m/s).
    b. Test Data (Indicated and Actual Values):
        1) Heat output in Btu/h (kW).
        2) Air flow rate in cfm (L/s).
        3) Air velocity in fpm (m/s).
        4) Entering-air temperature in deg F (deg C).
        5) Leaving-air temperature in deg F (deg C).
        6) Voltage at each connection.
        7) Amperage for each phase.
9. Fan Test Reports: For supply, return, and exhaust fans, include the following:
    a. Fan Data:
        1) System identification.
        2) Location.
        3) Make and type.
        4) Model number and size.
        5) Manufacturer's serial number.
        6) Arrangement and class.
        7) Sheave make, size in inches (mm), and bore.
        8) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
    b. Motor Data:
        1) Motor make, and frame type and size.
        2) Horsepower and rpm.
        3) Volts, phase, and hertz.
        4) Full-load amperage and service factor.
        5) Sheave make, size in inches (mm), and bore.
        6) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
        7) Number, make, and size of belts.
    c. Test Data (Indicated and Actual Values):
        1) Total airflow rate in cfm (L/s).
        2) Total system static pressure in inches wg (Pa).
        3) Fan rpm.
        4) Discharge static pressure in inches wg (Pa).
        5) Suction static pressure in inches wg (Pa).
10. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
    a. Report Data:

        1) System and air-handling-unit number.
        2) Location and zone.
        3) Traverse air temperature in deg F (deg C).
        4) Duct static pressure in inches wg (Pa).
        5) Duct size in inches (mm).
        6) Duct area in sq. ft. (sq. m).
        7) Indicated air flow rate in cfm (L/s).
        8) Indicated velocity in fpm (m/s).
        9) Actual air flow rate in cfm (L/s).
        10) Actual average velocity in fpm (m/s).
        11) Barometric pressure in psig (Pa).

11. Air-Terminal-Device Reports:
    a. Unit Data:
        1) System and air-handling unit identification.
        2) Location and zone.
        3) Apparatus used for test.
        4) Area served.
        5) Make.
        6) Number from system diagram.
        7) Type and model number.
        8) Size.
        9) Effective area in sq. ft. (sq. m).
    b. Test Data (Indicated and Actual Values):
        1) Air flow rate in cfm (L/s).
        2) Air velocity in fpm (m/s).
        3) Preliminary air flow rate as needed in cfm (L/s).
        4) Preliminary velocity as needed in fpm (m/s).
        5) Final air flow rate in cfm (L/s).
        6) Final velocity in fpm (m/s).
        7) Space temperature in deg F (deg C).
12. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
    a. Unit Data:
        1) System and air-handling-unit identification.
        2) Location and zone.
        3) Room or riser served.
        4) Coil make and size.
        5) Flowmeter type.
    b. Test Data (Indicated and Actual Values):
        1) Air flow rate in cfm (L/s).
        2) Entering-water temperature in deg F (deg C).
        3) Leaving-water temperature in deg F (deg C).
        4) Water pressure drop in feet of head or psig (kPa).
        5) Entering-air temperature in deg F (deg C).
        6) Leaving-air temperature in deg F (deg C).
13. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
    a. Unit Data:
        1) Unit identification.
        2) Location.
        3) Service.
        4) Make and size.
        5) Model number and serial number.
        6) Water flow rate in gpm (L/s).
        7) Water pressure differential in feet of head or psig (kPa).
        8) Required net positive suction head in feet of head or psig (kPa).
        9) Pump rpm.

        10) Impeller diameter in inches (mm).
        11) Motor make and frame size.
        12) Motor horsepower and rpm.
        13) Voltage at each connection.
        14) Amperage for each phase.
        15) Full-load amperage and service factor.
        16) Seal type.
    b. Test Data (Indicated and Actual Values):
        1) Static head in feet of head or psig (kPa).
        2) Pump shutoff pressure in feet of head or psig (kPa).
        3) Actual impeller size in inches (mm).
        4) Full-open flow rate in gpm (L/s).
        5) Full-open pressure in feet of head or psig (kPa).
        6) Final discharge pressure in feet of head or psig (kPa).
        7) Final suction pressure in feet of head or psig (kPa).
        8) Final total pressure in feet of head or psig (kPa).
        9) Final water flow rate in gpm (L/s).
        10) Voltage at each connection.
        11) Amperage for each phase.
14. Instrument Calibration Reports:
    a. Report Data:
        1) Instrument type and make.
        2) Serial number.
        3) Application.
        4) Dates of use.
        5) Dates of calibration.
15. Laboratories, vivarium, operating rooms, support spaces for the before mentioned rooms and other specialty rooms requiring minimum airflows and/or pressure differences. TAB report shall include:
    a. Minimum airflows required (e.g. air changes per hour, cfm per square foot), include design airflows.
    b. basis for requirements, (e.g. ASHRAE, CDC, NIH, USP 797, campus standard)
    c. pressure requirements (e.g. positive, negative, neutral)
    d. Achieved values for the above.

Z. Inspections
1. Initial Inspection:
    a. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
    b. Check the following for each system:
        1) Measure airflow of at least 10 percent of air outlets.
        2) Measure water flow of at least 5 percent of terminals.
        3) Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
        4) Verify that balancing devices are marked with final balance position.
        5) Note deviations from the Contract Documents in the final report.
2. Final Inspection:
    a. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by The University **OR** Owner **OR** Commissioning Authority, **as directed**.
    b. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of The University **OR** Owner **OR** Commissioning Authority, **as directed**.
    c. The University **OR** Owner **OR** Commissioning Authority, **as directed**, shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be

limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

    d. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
    e. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
3. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
    a. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
    b. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
4. Prepare test and inspection reports.

AA. Additional Tests

1. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
2. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 01 10 00a

SECTION 23 01 30 51 - HVAC AIR-DISTRIBUTION SYSTEM CLEANING

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for HVAC air-distribution system cleaning. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. Section includes cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

C. Definitions
   1. ASCS: Air systems cleaning specialist.
   2. NADCA: National Air Duct Cleaners Association.

D. Submittals
   1. Qualification Data: For an ASCS.
   2. Strategies and procedures plan.
   3. Cleanliness verification report.

E. Quality Assurance
   1. ASCS Qualifications: A certified member of NADCA.
      a. Certification: Employ an ASCS certified by NADCA on a full-time basis.
      b. Supervisor Qualifications: Certified as an ASCS by NADCA.
   2. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.
   3. Cleaning Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Fosters 40/30, USDA tested, 10 year warranty

B. Diffuser filters

1.3 EXECUTION

A. Examination
   1. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
   2. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
   3. Prepare written report listing conditions detrimental to performance of the Work.
   4. Proceed with work only after unsatisfactory conditions have been corrected.

B. Preparation
   1. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
      a. Supervisor contact information.
      b. Work schedule including location, times, and impact on occupied areas.
      c. Methods and materials planned for each HVAC component type.
      d. Required support from other trades.
      e. Equipment and material storage requirements.

    f. Exhaust equipment setup locations.
2. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
3. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

C. Cleaning
1. Comply with NADCA ACR 2006.
2. Remove visible surface contaminants and deposits from within the HVAC system.
3. Systems and Components to Be Cleaned:
    a. Air devices for supply and return air.
    b. Air-terminal units.
    c. Ductwork:
        1) Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
        2) Return-air ducts to the air-handling unit.
        3) Exhaust-air ducts.
    d. Air-Handling Units:
        1) Interior surfaces of the unit casing.
        2) Coil surfaces compartment.
        3) Condensate drain pans.
        4) Fans, fan blades, and fan housings.
    e. Filters and filter housings.
4. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
5. Particulate Collection:
    a. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
    b. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
6. Control odors and mist vapors during the cleaning and restoration process.
7. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
8. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
9. Clean all air-distribution devices, registers, grilles, and diffusers.
10. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
    a. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
    b. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
    c. Clean evaporator coils, reheat coils, and other airstream components.
11. Duct Systems:
    a. Create service openings in the HVAC system as necessary to accommodate cleaning.
    b. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
12. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
13. Mechanical Cleaning Methodology:
    a. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning

method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

1) Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
2) Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.

b. Cleaning Mineral-Fiber Insulation Components:
   1) Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
   2) Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
   3) Fibrous materials that become wet shall be discarded and replaced.

14. Coil Cleaning:
    a. Measure static-pressure differential across each coil.
    b. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
    c. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
    d. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
    e. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
    f. Rinse thoroughly with clean water to remove any latent residues.
15. Antimicrobial Agents, Coatings, and Sanitizers:
    a. Apply antimicrobial agents, coatings, and sanitizers if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
    b. When used, antimicrobial treatments, coatings, and sanitizers shall be applied after the system is rendered clean.
    c. Apply antimicrobial agents, coatings, and sanitizers directly onto surfaces of interior ductwork. Fogging is prohibited.
    d. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

D. Cleanliness Verification
   1. Prior to cleanliness verification install filter material in the diffuser. White side facing supply air.
   2. 2 weeks later inspect filter material
   3. If the filter material is clean then the distribution system is clean
      a. If the filter has particulates then replace the filter material
      b. Verify cleanliness 3 days later
   4. If filter material is clean then the distribution system is clean
      a. If the filter has particulates then re-clean back to the branch ductwork

E. Restoration
   1. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
   2. Restore service openings capable of future reopening. Comply with requirements in Division 23 Section "Metal Ducts". Include location of service openings in Project closeout report.

3. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Division 23 Section(s) "Metal Ducts" AND "Nonmetal Ducts"
4. Replace damaged insulation according to Division 23 Section "Hvac Insulation",
5. Ensure that closures do not hinder or alter airflow.
6. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
7. Reseal fibrous-glass ducts. Comply with requirements in Division 23 Section "Nonmetal Ducts".

END OF SECTION 23 01 30 51

SECTION 23 05 00 00 - MOTORS

PART 1 GENERAL

1.01 The following sections are to be included as if written herein:

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
- C. Section 23 05 53 – Mechanical Identification

1.02 SECTION INCLUDES

- A. Single phase electric motors
- B. Three phase electric motors
- C. The Contractor shall provide all motors required for equipment supplied under this Division of the work

1.03 RELATED WORK

- A. Section 22 15 19 - Reciprocating Air Compressors
- B. Section 23 22 00.A - Steam and Steam Condensate Specialties: Condensate pumps
- C. Section 23 20 00 - HVAC Pumps
- D. Section 23 73 00 – Fan Coil Units Fan motors
- E. Section 23 34 00 - Fans

1.04 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings
- C. ANSI/IEEE 112 Test Method B - Test Procedure for Polyphase Induction Motors and Generators
- D. ANSI/NEMA MG 1 - Motors and Generators
- E. ANSI/NFPA 70 - National Electrical Code

1.05 SUBMITTALS

- A. Submit product data under provisions of Section 23 00 00
- B. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.
- C. Submit manufacturer's installation instructions under provisions of Section 23 00 00

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 00
- B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three—years documented product development, testing, and manufacturing experience.

1.08 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 70.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.10 WARRANTY

A. Provide three year manufacturer's warranty under provisions of Section 23 00 00.

B. Motors failing during warranty shall be replaced with a new motor.

C. Warranty: Include coverage for motors 1 horsepower and larger.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Refer to Drawing Schedules for required electrical characteristics.

B. All Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.

C. Totally Enclosed Motors: Design for a service factor of 1.15 and an 80 degrees C maximum temperature rise in the same conditions.

D. Visible Stainless Steel Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, bearing sizes, wiring diagram, manufacturer's name and model number, Service Factor, Power Factor and Nominal Efficiency, efficiency.

E. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

F. Motors shall be built in accordance with the latest ANSI, IEEE, and NEMA Standards, and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled, and of approved manufacture as described herein or of the same manufacture as the equipment which they serve. All motors provided by the Contractor shall be of the same manufacture unless they are an integral part of the piece of equipment to which they are attached. Nameplate rating of motors shall match the characteristics scheduled.

G. All motors shall be designed for NEMA Design B starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.

H. In addition, all motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

I. Dynamic Balance shall be no greater than the vibration limits of the driven equipment as defined in Section 23 34 00 for fans and Section 23 20 00 for pumps.

J. All motors shall be provided with all copper windings, terminal wiring, and copper or bronze lugs. AL/CU rated connectors are not allowed.

2.02 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

F. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors with drip-proof enclosures except as hereinafter specified. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.03 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

E. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.04 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

H. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class F insulation.

B. In general, all motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 480V 3-phase and shall be squirrel cage premium efficiency induction type with standard NEMA frame sizes.

C. Motors 1 HP and larger shall have integral frames and be provided with copper grounding lug.

D. Starting Torque: Between one and one and one-half times full load torque.

E. Starting Current: Six times full load current.

F. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B Characteristics.

G. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG 1 for Design B motors.

H. Insulation System: NEMA Class F or better.

I. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Test and balance motors to limits defined in 2.01J.

J. Motor Frames: NEMA standard T-frames of cast iron with end brackets of cast iron.

K. Bearings: Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication. All motor bearings shall be factory pre-packed with a non-detergent lubricant, and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter. Permanently lubricated factory-sealed motors may be provided in fractional HP sizes only where they are an integral part of a piece of approved apparatus. All bearings shall be designed for B-10, 200,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: Refer to ANSI/NEMA MG 1.

M. Weatherproof Epoxy Treated Motors (Where Indicated): Epoxy coat windings with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.

N. Nominal Efficiency: Meet or exceed values for NEMA premium efficiency electric motors at full load and rated voltage when tested in accordance with ANSI/IEEE 112, Test Method B.

O. Nominal Power Factor: Meet or exceed values per EPACT 2001 at full load and rated voltage when tested in accordance with ANSI/IEEE 112, Test Method B.

P. Motors 1 HP and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.

Q. Motors 10HP and larger shall be inverter duty rated and shall be provided with shaft grounding device.

2.06 STARTING EQUIPMENT:

A. Each motor shall be provided with proper starting equipment. This equipment, unless hereinafter specified or scheduled to the contrary, shall be provided by the trade furnishing the motor. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted. The Mechanical Subcontractor shall furnish all starters for Division 23 work, except those starters scheduled to be provided in Division 26 Motor Control Centers.

B. Control transformers shall have two primary fuses and one secondary fuse.

C. Motor starters shall conform to NEMA Standards for Industrial Control, #IC-1, latest issue, and shall be housed in NEMA Standard enclosures. Control voltage in each starter shall be not more than 120 volts to ground, with an individual control transformer provided in each starter as required. Manual starters for fractional horsepower single-phase motors shall be on-off or snap switch type combined with thermal overload device. The switch shall be so constructed so that it cannot be held closed under a sustained motor overload.

D. Magnetic starters shall have thermal overload protection in each of the ungrounded legs and shall be solenoid operated. Provide the correct size heater element to protect the motor and allow it to operate based on motor nameplate amperes and ambient temperatures anticipated for each individual motor. Each starter shall be provided with a control power transformer or 120v control power circuit.

E. Pushbuttons with or without pilot lights, hand-off-automatic switches, red-run/green-off lights and other scheduled apparatus shall be standard duty type mounted in NEMA enclosures or in cover of starter as specified or scheduled and shall be furnished by the trade furnishing the starter except as specifically indicated elsewhere.

F. Hand-Off-Automatic switches for equipment which could damage itself if left in the "hand" position (such as sump pumps), shall be spring return to "off" from the "hand" position.

PART 3 EXECUTION

3.01 APPLICATION

A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Motors shall be premium energy efficient type.

D. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

E. Motors located in exterior locations for direct drive axial fans shall be totally enclosed type.

3.02 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600_RPM	1800_RPM	1200_RPM	900_RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

END OF SECTION 23 05 00 00

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SECTION 23 05 13 00 - ELECTRICAL RENOVATION

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for electrical renovation. Products shall be as approved by The University. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Quality Assurance

1. Regulatory Requirements: Comply with following:
   a. Electrical: National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code (NEC).
   b. Accessibility:
      1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
         a) Uniform Federal Accessibility Standards (UFAS).
      2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
      3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
      4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).

Project Conditions

2. Existing Conditions: Buildings will be occupied during construction. See Division 1 Section “Summary of Work.” Do not interfere with use of occupied portions of building. Maintain free and safe passage to and from occupied areas.

Scheduling And Sequencing

3. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Alterations, Cutting And Protection

4. Protection: Protect existing finishes, equipment, utilities and adjacent work, which is scheduled to remain, from damage.
5. Existing Operating Facilities: Confine operations to immediate vicinity of new work and do not interfere with or obstruct ingress or egress to and from adjacent facilities.

PRODUCTS

Materials

6. Electrical Materials and Devices: Comply with NFPA 70 (NEC):
   a. Boxes: Galvanized steel, not less than 1.6 mm (0.0625 inch) thickness (NEC 370-20) grounded in accordance with NEC, Article 250, suitable for recess mounting.
      1) Provide boxes of appropriate shape and size for intended purpose.
   b. Devices:
      1) Duplex Receptacles: 20 A 115 V, UL Listed with screw side connections and corrugated bearing pads.
         a) GFIC Outlets: 115 V, 60 Hz, 20 A rating, UL Listed.
      2) Switches: 20 A. 115 V, single pole, single throw switch, UL Listed, with side screw connections and corrugated bearing pads.

- a) Garbage Disposal: Heavy duty, 120/277 VAC, 60 Hz, single pole, single throw, 20 A rate, UL listed and CSA certified.
- 3) Cover Plates: Smooth plastic in color to match existing.
- c. Wiring: Insulated wire, Type NM 600 V with ground wire, sized as appropriate for intended purpose and in accordance with NEC.
  - 1) Aluminum Wire: Not allowed unless existing wiring is aluminum.
  - 2) Provide necessary fittings in accordance with NEC.

EXECUTION

Examination

7. Units, Spaces and Areas to be Renovated: Inspect to become familiar with existing conditions and to take measurements which are necessary for renovation work to be completed in accordance with contract requirements.
   - a. Carefully inspect condition of existing spaces including, but not limited to walls, floors, plumbing, electrical, etc. as essential to successful completion of renovation work.
   - b. Survey each space and verify dimensions for work.

Preparation

8. Building Occupation: Carry out renovation work to cause as little inconvenience to occupants as possible. See Division 1 Section “Summary of Work.”
9. Protection: Protect and be responsible for existing buildings, facilities, utilities, and improvements within areas of construction operations.
   - a. Tenant's Property: Be responsible for any damage or loss to residents' property and to other work. Replace any material, which, in opinion of The University, has become damaged to extent that it could not be restored to its original condition.
   - b. Take precautions to protect residents and public from injury from construction operations.

Laying Out Work

10. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
    - a. Prior to commencing work, carefully compare and check Drawings (if any), for discrepancies in locations or elevations of work to be executed.
    - b. Refer discrepancies among Drawings (if any), Specifications and existing conditions to The University for adjustment before work affected is performed.
      - 1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
11. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

Location Of Equipment And Piping

12. Drawings (if any) indicating location of equipment, piping, ductwork, etc. are diagrammatic and job conditions shall not always permit their installation in location shown. When this situation occurs, bring condition to The University's attention immediately. Relocation will be determined in joint conference.
13. Contractor: Do not relocate any items without first obtaining The University's acceptance. Remove and relocate such relocated items at own expense if so directed.

Electrical Work

14. General: Install boxes, wiring, and devices as indicated and required to connect and control electrical devices in accordance with NFPA 70 (NEC).
    - a. Boxes: Solidly anchor to framing or blocking.
15. Removing Electrical Switch or Duplex Outlet (Non-Hazardous Locations):
    - a. Box to Remain:
      - 1) Remove electrical device; cap hot and neutral with set-screw wire connectors.
      - 2) Attach ground wire to remaining box with solid screw attachment.

3) Provide and install natural finish aluminum blank cover plate with screw fasteners integral to match size of box remaining.

b. Box to be removed:

1) Remove electrical device and box and pull wire out of wall back to first circuit panel, disconnecting from circuit panel.

2) Patch and repair hole in partition to match existing.

16. Garbage Disposal Electrical Hook-up: See Division 15 Section “Plumbing.” Comply with NFPA 70 (NEC):

a. Wiring: Install from disposal through concealed spaces to house panel, anchoring wire, and providing necessary fittings.

b. Switch: Install above counter top backsplash.

17. Range Hood Electrical Hook-up: See Division 11 Section “Residential Appliances.” Comply with NFPA 70 (NEC):

a. Electric service: Install insulated wire from range hood through concealed spaces to house panel, anchoring wire, and providing necessary fittings.

18. Water Heater Electrical Hook-up: See Division 15 Section “Domestic Water Heaters.” Comply with NFPA 70 (NEC).

19. Furnace Electrical Hook-up: See Division 15 Section “Furnaces.” Comply with NFPA 70 (NEC).

20. Smoke Detector Electrical Hook-up: See Division 13 Section “Fire Alarm.” Comply with NFPA 70 (NEC).

Integrating Existing Work

21. Protection: Protect existing improvements from damage.

a. Where new work is to be connected to existing work, exercise special care not to disturb or damage existing work more than necessary.

b. Damaged Work: Replace, repair and restored to its original condition at no cost to Owner.

END OF SECTION 23 05 13 00

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SECTION 23 05 19 00 - METERS AND GAUGES FOR HVAC PIPING

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for meters and gauges for HVAC piping. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. Section Includes:
    a. Bimetallic-actuated thermometers.
    b. Filled-system thermometers.
    c. Liquid-in-glass thermometers.
    d. Light-activated thermometers.
    e. Thermowells.
    f. Dial-type pressure gauges.
    g. Gauge attachments.
    h. Test plugs.
    i. Test-plug kits.
    j. Sight flow indicators.
    k. Orifice flowmeters.
    l. Pitot-tube flowmeters.
    m. Turbine flowmeters.
    n. Venturi flowmeters.
    o. Vortex-shedding flowmeters.
    p. Impeller-turbine, thermal-energy meters.
    q. Ultrasonic, thermal-energy meters.

C. Submittals
  1. Product Data: For each type of product indicated.
  2. Wiring Diagrams: For power, signal, and control wiring.
  3. Product Certificates: For each type of meter and gauge, from manufacturer.
  4. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

1.2 PRODUCTS

A. Bimetallic-Actuated Thermometers
  1. Standard: ASME B40.200.
  2. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch (76-mm) **OR** 5-inch (127-mm), **as directed**, nominal diameter.
  3. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C) **OR** deg F and deg C, **as directed**.
  4. Connector Type(s): Union joint, adjustable angle **OR** rigid, back **OR** rigid, bottom, **as directed**, with unified-inch screw threads.
  5. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
  6. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
  7. Window: Plain glass or plastic.
  8. Ring: Stainless steel.
  9. Element: Bimetal coil.
  10. Pointer: Dark-colored metal.
  11. Accuracy: Plus or minus 1 **OR** 1.5, **as directed**, percent of scale range.

B. Filled-System Thermometers
  1. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
    a. Standard: ASME B40.200.
    b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
    c. Element: Bourdon tube or other type of pressure element.
    d. Movement: Mechanical, dampening type, **as directed**, with link to pressure element and connection to pointer.
    e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
    f. Pointer: Dark-colored metal.
    g. Window: Glass or plastic.
    h. Ring: Metal **OR** Stainless steel.
    i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
    j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
    k. Accuracy: Plus or minus 1 percent of scale range.
  2. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
    a. Standard: ASME B40.200.
    b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
    c. Element: Bourdon tube or other type of pressure element.
    d. Movement: Mechanical, with link to pressure element and connection to pointer.
    e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
    f. Pointer: Dark-colored metal.
    g. Window: Glass or plastic.
    h. Ring: Metal or plastic.
    i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
    j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
    k. Accuracy: Plus or minus 1 percent of scale range.
  3. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
    a. Standard: ASME B40.200.
    b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
    c. Element: Bourdon tube or other type of pressure element.
    d. Movement: Mechanical, with link to pressure element and connection to pointer.
    e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
    f. Pointer: Dark-colored metal.
    g. Window: Glass or plastic.
    h. Ring: Metal **OR** Stainless steel, **as directed**.
    i. Connector Type(s): Union joint, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
    j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

- 1) Design for Air-Duct Installation: With ventilated shroud.
- 2) Design for Thermowell Installation: Bare stem.

k. Accuracy: Plus or minus 1 percent of scale range.

4. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
    - a. Standard: ASME B40.200.
    - b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
    - c. Element: Bourdon tube or other type of pressure element.
    - d. Movement: Mechanical, with link to pressure element and connection to pointer.
    - e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
    - f. Pointer: Dark-colored metal.
    - g. Window: Glass or plastic.
    - h. Ring: Metal or plastic.
    - i. Connector Type(s): Union joint, threaded, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
    - j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
        - 1) Design for Air-Duct Installation: With ventilated shroud.
        - 2) Design for Thermowell Installation: Bare stem.
    - k. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Liquid-In-Glass Thermometers

1. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
    - a. Standard: ASME B40.200.
    - b. Case: Cast aluminum; 6-inch (152-mm) nominal size.
    - c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
    - d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
    - e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
    - f. Window: Glass or plastic.
    - g. Stem: Aluminum or brass and of length to suit installation.
        - 1) Design for Air-Duct Installation: With ventilated shroud.
        - 2) Design for Thermowell Installation: Bare stem.
    - h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
    - i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
2. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
    - a. Standard: ASME B40.200.
    - b. Case: Plastic; 6-inch (152-mm) nominal size.
    - c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
    - d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
    - e. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
    - f. Window: Glass or plastic.
    - g. Stem: Aluminum or brass and of length to suit installation.
        - 1) Design for Air-Duct Installation: With ventilated shroud.
        - 2) Design for Thermowell Installation: Bare stem.
    - h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
    - i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
3. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
    - a. Standard: ASME B40.200.
    - b. Case: Cast aluminum; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.

        c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
        d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
        e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
        f. Window: Glass or plastic.
        g. Stem: Aluminum and of length to suit installation.
            1) Design for Air-Duct Installation: With ventilated shroud.
            2) Design for Thermowell Installation: Bare stem.
        h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
        i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
    4. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
        a. Standard: ASME B40.200.
        b. Case: Plastic; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
        c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
        d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
        e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
        f. Window: Glass or plastic.
        g. Stem: Aluminum **OR** Brass **OR** Stainless steel, **as directed**, and of length to suit installation.
            1) Design for Air-Duct Installation: With ventilated shroud.
            2) Design for Thermowell Installation: Bare stem.
        h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
        i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Light-Activated Thermometers
    1. Direct-Mounted, Light-Activated Thermometers:
        a. Case: Plastic **OR** Metal, **as directed**; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
        b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
        c. Case Form: Adjustable angle.
        d. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
        e. Stem: Aluminum and of length to suit installation.
            1) Design for Air-Duct Installation: With ventilated shroud.
            2) Design for Thermowell Installation: Bare stem.
        f. Display: Digital.
        g. Accuracy: Plus or minus 2 deg F (1 deg C).
    2. Remote-Mounted, Light-Activated Thermometers:
        a. Case: Plastic, for wall mounting.
        b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
        c. Sensor: Bulb and thermistor wire.
            1) Design for Air-Duct Installation: With ventilated shroud.
            2) Design for Thermowell Installation: Bare stem.
        d. Display: Digital.
        e. Accuracy: Plus or minus 2 deg F (1 deg C).

E. Duct-Thermometer Mounting Brackets
    1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

F. Thermowells

1. Thermowells:
   - a. Standard: ASME B40.200.
   - b. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   - c. Material for Use with Copper Tubing: CNR **OR** CUNI, **as directed**.
   - d. Material for Use with Steel Piping: CRES **OR** CSA, **as directed**.
   - e. Type: Stepped shank unless straight or tapered shank is indicated.
   - f. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
   - g. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
   - h. Bore: Diameter required to match thermometer bulb or stem.
   - i. Insertion Length: Length required to match thermometer bulb or stem.
   - j. Lagging Extension: Include on thermowells for insulated piping and tubing.
   - k. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
2. Heat-Transfer Medium: Mixture of graphite and glycerin.

G. Pressure Gauges

1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges:
   - 1) Standard: ASME B40.100.
   - 2) Case: Liquid-filled **OR** Sealed **OR** Open-front, pressure relief **OR** Solid-front, pressure relief, **as directed**, type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   - 3) Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   - 4) Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   - 5) Movement: Mechanical, with link to pressure element and connection to pointer.
   - 6) Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   - 7) Pointer: Dark-colored metal.
   - 8) Window: Glass or plastic.
   - 9) Ring: Metal **OR** Brass **OR** Stainless steel, **as directed**.
   - 10) Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
2. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gauges:
   - a. Standard: ASME B40.100.
   - b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   - c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   - d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   - e. Movement: Mechanical, with link to pressure element and connection to pointer.
   - f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   - g. Pointer: Dark-colored metal.
   - h. Window: Glass or plastic.
   - i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
3. Remote-Mounted, Metal-Case, Dial-Type Pressure Gauges:
   - a. Standard: ASME B40.100.
   - b. Case: Liquid-filled **OR** Sealed, **as directed**, type; cast aluminum or drawn steel **OR** metal, **as directed**; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   - c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
e. Movement: Mechanical, with link to pressure element and connection to pointer.
f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
g. Pointer: Dark-colored metal.
h. Window: Glass or plastic.
i. Ring: Metal **OR** Stainless steel, **as directed**.
j. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.

4. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gauges:
   a. Standard: ASME B40.100.
   b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.

H. Gauge Attachments
1. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and piston-type **OR** porous-metal-type, **as directed**, surge-dampening device. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of brass **OR** stainless-steel **OR** steel, **as directed**, pipe with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, pipe threads.
3. Valves: Brass ball **OR** Brass or stainless-steel needle, **as directed**, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads.

I. Test Plugs
1. Description: Test-station fitting made for insertion into piping tee fitting.
2. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
3. Thread Size: NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe thread.
4. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
5. Core Inserts: Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber.

J. Test-Plug Kits
1. Furnish one test-plug kit(s) containing one **OR** two, **as directed**, thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
2. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
3. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).

4. Pressure Gauge: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
5. Carrying Case: Metal or plastic, with formed instrument padding.

K. Sight Flow Indicators
  1. Description: Piping inline-installation device for visual verification of flow.
  2. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
  3. Minimum Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1034 kPa), **as directed**.
  4. Minimum Temperature Rating: 200 deg F (93 deg C).
  5. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
  6. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

L. Flowmeters
  1. Orifice Flowmeters:
    a. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
    b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
    c. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.
      1) Design: Differential-pressure-type measurement for gas **OR** oil **OR** steam **OR** water, **as directed**.
      2) Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
      3) Minimum Pressure Rating: 300 psig (2070 kPa).
      4) Minimum Temperature Rating: 250 deg F (121 deg C).
    d. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
    e. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot (3.7-m) hoses, with carrying case.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
    f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
    g. Conversion Chart: Flow rate data compatible with sensor and indicator.
    h. Operating Instructions: Include complete instructions with each flowmeter.
  2. Pitot-Tube Flowmeters:
    a. Description: Flowmeter with sensor and indicator.
    b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
    c. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute (liters per second).
      1) Design: Differential-pressure-type measurement for oil **OR** water, **as directed**.
      2) Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
      3) Minimum Pressure Rating: 150 psig (1035 kPa).
      4) Minimum Temperature Rating: 250 deg F (121 deg C).
    d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
    e. Integral Transformer: For low-voltage power connection.
    f. Accuracy: Plus or minus 3 percent.
    g. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
    h. Operating Instructions: Include complete instructions with each flowmeter.
  3. Turbine Flowmeters:
    a. Description: Flowmeter with sensor and indicator.

b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

c. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute (liters per second).
    1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for gas **OR** oil **OR** steam **OR** water, **as directed**.
    2) Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
    3) Minimum Pressure Rating: 150 psig (1035 kPa).
    4) Minimum Temperature Rating: 180 deg F (82 deg C).

d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.

e. Accuracy: Plus or minus 1-1/2 percent.

f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).

g. Operating Instructions: Include complete instructions with each flowmeter.

4. Venturi Flowmeters:
    a. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
    b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
    c. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
        1) Design: Differential-pressure-type measurement for gas **OR** oil **OR** steam **OR** water, **as directed**.
        2) Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
        3) Minimum Pressure Rating: 250 psig (1725 kPa).
        4) Minimum Temperature Rating: 250 deg F (121 deg C).
        5) End Connections for NPS 2 (DN 50) and Smaller: Threaded.
        6) End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
        7) Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
    d. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
        1) Scale: Gallons per minute (Liters per second).
        2) Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
    e. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot (3.7-m) hoses, with carrying case.
        1) Scale: Gallons per minute (Liters per second).
        2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
    f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
    g. Conversion Chart: Flow rate data compatible with sensor.
    h. Operating Instructions: Include complete instructions with each flowmeter.

5. Vortex-Shedding Flowmeters:
    a. Description: Flowmeter with sensor and indicator.
    b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
    c. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in gallons per minute (liters per second).
        1) Design: Flow obstruction device, vortex-measurement type for gas **OR** steam **OR** liquids, **as directed**.
        2) Construction: Stainless-steel body, with integral transmitter and direct-reading scale.
        3) Minimum Pressure Rating: 1000 psig (6900 kPa).
        4) Minimum Temperature Rating: 500 deg F (260 deg C).
        5) Integral Transformer: For low-voltage power operation.
    d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
    e. Accuracy: Plus or minus 0.25 percent for liquids and 0.75 percent for gases.

f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
g. Operating Instructions: Include complete instructions with each flowmeter.

M. Thermal-Energy Meters
1. Impeller-Turbine, Thermal-Energy Meters:
a. Description: System with strainer, **as directed**, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
b. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.
1) Design: Total thermal-energy measurement.
2) Minimum Pressure Rating: 150 psig (1035 kPa).
3) Minimum Temperature Range: 40 to 250 deg F (5 to 121 deg C).
c. Temperature Sensors: Insertion-type transducer.
d. Indicator: Solid-state, integrating-type meter with integral battery pack, **as directed**; for wall mounting.
1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
2) Battery Pack: Five-year lithium battery.
e. Accuracy: Plus or minus 1 percent.
f. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
g. Strainer: Full size of main line piping.
h. Operating Instructions: Include complete instructions with each thermal-energy meter system.
2. Ultrasonic, Thermal-Energy Meters:
a. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
b. Flow Sensor: Transit-time ultrasonic type with transmitter.
c. Temperature Sensors: Insertion-type or strap-on transducer.
d. Indicator: Solid-state, integrating-type meter with integral battery pack, **as directed**.
1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
2) Battery Pack: Five-year lithium battery.
e. Accuracy: Plus or minus 1 percent.
f. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
g. Operating Instructions: Include complete instructions with each thermal-energy meter system.

1.3 EXECUTION

A. Installation
1. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid **OR** one-third of pipe diameter **OR** to center of pipe, **as directed**, and in vertical position in piping tees.
2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
3. Install thermowells with extension on insulated piping.
4. Fill thermowells with heat-transfer medium.
5. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
6. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
7. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
8. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
9. Install remote-mounted pressure gauges on panel.
10. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

11. Install valve and syphon fitting in piping for each pressure gauge for steam.
12. Install test plugs in piping tees.
13. Install flow indicators in piping systems in accessible positions for easy viewing.
14. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
15. Install flowmeter elements in accessible positions in piping systems.
16. Install wafer-orifice flowmeter elements between pipe flanges.
17. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
18. Install permanent indicators on walls or brackets in accessible and readable positions.
19. Install connection fittings in accessible locations for attachment to portable indicators.
20. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
21. Install thermometers in the following locations:
    a. Inlet and outlet of each hydronic zone.
    b. Inlet and outlet of each hydronic boiler.
    c. Two inlets and two outlets of each chiller.
    d. Inlet and outlet of each hydronic coil in air-handling units.
    e. Two inlets and two outlets of each hydronic heat exchanger.
    f. Inlet and outlet of each thermal-storage tank.
    g. Outside-, return-, supply-, and mixed-air ducts.
22. Install pressure gauges in the following locations:
    a. Discharge of each pressure-reducing valve.
    b. Inlet and outlet of each chiller chilled-water and condenser-water connection.
    c. Suction and discharge of each pump.

B. Connections
1. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.
2. Connect flowmeter-system elements to meters.
3. Connect flowmeter transmitters to meters.
4. Connect thermal-energy meter transmitters to meters.

C. Adjusting
1. After installation, calibrate meters according to manufacturer's written instructions.
2. Adjust faces of meters and gauges to proper angle for best visibility.

D. Thermometer Schedule
1. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
2. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Thermometers at inlets and outlets of each chiller shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.

    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
  4. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
  5. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
  6. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
  7. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
  8. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
  9. Thermometer stems shall be of length to match thermowell insertion length.

E. Thermometer Scale-Range Schedule
  1. **Scale shall be as near 2X system temperature being measured, as available in commonly manufactured gauges**.
  2.

F. Pressure-Gauge Schedule
  1. Pressure gauges at discharge of each pressure-reducing valve shall be one of the following:
    a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
    b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.

   c. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
2. Pressure gauges at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
   b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.
   c. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Pressure gauges at suction and discharge of each pump shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
   b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.
   c. Test plug with Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

G. Pressure-Gauge Scale-Range Schedule
   1. **Scale shall be as near 2X system pressure being measured, as available in commonly manufactured gauges**.

H. Flowmeter Schedule
   1. Flowmeters for Chilled-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
   2. Flowmeters for Condenser-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
   3. Flowmeters for Heating, Hot-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
   4. Flowmeters for Steam and Steam-Condensate Piping: Orifice **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.

I. Thermal-Energy Meter Schedule
   1. Thermal-Energy Meters for Chilled-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
   2. Thermal-Energy Meters for Condenser-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
   3. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
   4. Thermal-Energy Meters for Steam and Steam-Condensate Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.

END OF SECTION 23 05 19 00

SECTION 23 07 13 00 - DUCTWORK INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install ductwork insulation and jackets indicated by the Contract Documents with supplementary items necessary for proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM C168 - Terminology Relating to Thermal Insulation Materials.
3. ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
4. ASTM C553 - Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
5. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
6. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
7. ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
8. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
9. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
10. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
11. ASTM E84 - Surface Burning Characteristics of Building Materials.
12. ASTM E96 - Water Vapor Transmission of Materials.

13. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
14. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
15. NFPA 255 - Surface Burning Characteristics of Building Materials.
16. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
17. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
18. UL 723 - Surface Burning Characteristics of Building Materials.
19. UL 1978 - Standard for Grease Ducts.

1.04 QUALITY ASSURANCE

A. All ductwork requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.

B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s submittal data for this Section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

C. Application Company Qualifications: Company performing the Work of this Section must have minimum three (3) years experience specializing in the trade.

D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.

E. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be acceptable. Jacketing must be intact, no cuts, chaffing, or tears will be acceptable. Jacketing will not be in contact with anything the will compress the insulation or compromise thermal integrity of the insulation.

1.05 SUBMITTALS

A. Product Data:

   1. Provide product description, list of materials, “k” value, “R” value, mean temperature range, and thickness for each service and location.

B. Record Documents:

   1. Submit under provisions of Division 01.

C. Operation and Maintenance Data:

   1. Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type.

2. Manufacturer’s Installation Instructions: Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to the Project Site under provisions of Division 01 and Division 20.

B. Deliver materials to Site in original factory packaging, labeled with manufacturer’s identification including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Knauf Corporation.

B. Or approved equal.

2.03 INSULATION MATERIALS

A. Type D1: Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; 'k' value of 0.25 at 75 degrees F; 1.5 lb./cu ft minimum density; 0.002 inch foil scrim Kraft facing for air ducts.

B. Type D2: Rigid glass fiber; ASTM C612, Class 1; 'k' value of 0.23 at 75 degrees F; 3.0 lb./cu ft minimum density; 0.002 inch foil scrim Kraft facing for air ducts.

C. Type D3: Duct liner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, ‘k’ value of 0.23 at 75 degrees F; 3.0 lb./cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable acrylic surface coating specifically formulated to:

1. Be no more corrosive than sterile cotton when tested in accordance with the test method for corrosiveness in ASTM C665.

2. Absorb no more than 3 percent by weight when tested in accordance with the test method for moisture vapor sorption in ASTM C1104.

3. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM C1071, ASTM C1338, ASTM G21, and ASTM G22.

4. Show no signs of warpage, cracking, delamination, flaming, smoking, glowing, or any other visibly negative changes when tested in accordance with the test method for temperature resistance in ASTM C411.

5. Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.

6. Meet the sound absorption requirements when tested in accordance with the test method for sound absorption in ASTM C423.

7. Show no evidence of continued erosion, cracking, flaking, peeling, or delamination when tested in accordance with the test method for erosion resistance in UL181.

D. Type D4: Fire Rated Grease Duct Insulation (High Temperature Flexible Blanket); 1-1/2-inch thick refractory grade fibrous fire barrier material with minimum service temperature design of 2,000 degrees F; aluminum foil laminated on both sides; with a minimum ‘k’ value of 0.25 and a minimum density of 6 lbs./cu ft; containing no asbestos. UL listed and tested to meet UL Standard 1978, ASTM E119, and with flame spread/smoke developed rating of 0 / 0 when tested as per ASTM E84/UL 723.

E. Type D5: Outdoor Duct Insulation (Closed Cell Flexible Elastomeric Insulation); 1 inch thick material that has a service temperature range from –60 degrees F to 180 degrees F. This outdoor duct insulation meets ASTM C 177 or C 518 and shall have minimum ‘k’ value of 0.27 Btu-in. / hr-ft^2-degrees F at minimum density measurement of 3 lb./cu ft. The insulation and outside surface must be protected with a white Thermo Plastic Rubber Membrane formulated to:

1. Be resistant to UV, and ozone, acid rain, and physical elements produced from outdoor weather per ASTM E 96 Procedure A.

2. Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.

3. Show no evidence of continued erosion, cracking, flaking, peeling, or delamination when tested in accordance with the test method for erosion resistance in UL181. Be resistant to mold growth resistance, ASTM G 21/C 1338 resistant to fungi, and resistant to bacteria growth per ASTM G 22.

2.04 INSULATION ACCESSORIES

A. Adhesives: Waterproof vapor barrier type, meeting requirements of ASTM C916; Childers CP-82.

B. Finish: Vapor barrier finish coating, Childers CP-11.

C. Jacket: Presized glass cloth, minimum 7.8 oz/sq. yd.

D. Type D4 Insulation Adhesive: Fire resistive to ASTM E84, Childers CP-82.

E. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

F. Joint Tape: Glass fiber cloth, open mesh.

G. Tie Wire and Wire Mesh: Annealed steel, 16 gage.

H. Stainless Steel Banding: 3/4-inch wide, minimum 22 gage, 304 stainless.

I. Armaflex 520 or 520 BLV contact adhesive.

J. Armatuff 25 white seal seam tape.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

C. Maintain required ambient temperature during and after installation for a minimum period of 24 hours.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Provide external insulation on all round ductwork connectors to ceiling diffusers and on top of diffusers as indicated in the Ductwork Insulation Application and Thickness Schedule and the Drawings. Secure insulation to ceiling diffuser frame with vapor barrier adhesive or tape to match jacket.

D. Flexible and Rigid fiberglass insulation (Types D1 and D2) application for exterior of duct:

1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.

2. Install without sag on underside of ductwork. Use 4-inch wide strips of adhesive on 8-inch centers and mechanical fasteners where necessary to prevent sagging. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

3. Insulate standing seams and stiffeners that protrude through the insulation with 1-1/2 inch thick, unfaced, flexible blanket insulation. Cover with glass cloth and coat with vapor barrier finish coating.

4. On circumferential joints, the 2-inch flange on the facing shall be secured with 9/16 inch outward clinch steel staples on 2-inch centers and taped with minimum 3-inch wide strip of glass fabric and finish coating.

5. Cover seams, joints, pin penetrations and other breaks finish coating reinforced with glass cloth.

E. Duct Liner (Type D3) application for interior of return air sound boots:

1. Secure insulation with 100 percent coverage of lagging adhesive, pins and clips not more than 18 inches on center.

2. Secure bottom of duct insulation using alternate single and double clips. The first pin will secure the insulation and the second clip will be used to secure the cladding. Isolate the exterior clip from the cladding by using two 1/8 inch closed cell neoprene (Armaflex) washers on either side of the cladding. Predrill holes in cladding and avoid contact with pin during installation.

3. For round duct, secure insulation with 100 percent coverage of lagging adhesive. Secure cladding with 3/4 inch, 0.020 inch stainless steel bands on 12-inch centers.

4. For joints and overlaps, fold cladding to form a double thickness hem 2 inches minimum. Seal with a non-shrink, non-hardening sealing compound.

F. Insulation (Type D4) application for exterior of grease ducts:

1. External duct wrap system requires two (2) 1.5-inch layers of lightweight, flexible wrap overlapped to provide an effective fire barrier. The barrier is installed in 24-inch or 48-inch wide sections. Insulation pins are welded in certain locations to maintain the fire barrier material up against the duct.

2. Typical installation of a rectangular duct with clean-out/access door and through floor/roof penetrations is as follows:

a. Insulation Pin Installation: Insulation pins shall be CD welded at various locations on the bottom, sides, and vertical sections of the ducts when the dimensions equal or exceed 18-inch. Pins shall be evenly spaced 8-inch to 12-inch apart from each other and from the bottom or side edges of the duct. To accommodate the overlaps rows of pins shall be spaced on 10.5-inch centers when straight runs of 24-inch wide pieces are being used and 11.25-inch centers when straight runs of 48-inch wide pieces are used. In transition areas (at bends and elbows) and at access door openings additional pins shall be used to assure integrity of the fire barrier.

b. The first layer of external duct wrap is composed of bottom and top pieces. The length of the pieces is dictated by the perimeter of the duct with allowances for a 3-inch overlap of the ends and radiuses at the corners. In straight runs, the bottom layers shall be installed so that the edges of the blankets are 18-inch from each other when using 24-inch wide material and 42-inch from each other when using 48-inch wide material. The top piece of the first layer shall be laid over the bottom pieces so that a 3-inch minimum overlap is achieved with the two bottom pieces it contacts. Tape shall be used to hold the pieces in position. A perimeter joint shall be formed where the ends of the blankets meet and overlapped a minimum of 3-inch. These perimeter joints shall be minimum of 3-inch. These perimeter joints shall be staggered at least 12-inch from one another.

c. The second layer of external duct wrap shall be composed of bottom and top pieces. Second layer pieces shall be longer than the first layer pieces, but installation is the same as the first layer, except that the edges of top wrap are offset from the bottom layer. In the case of 24-inch wide wraps the offset shall be 12-inch and for 48-inch the offset shall be 24-inch. Perimeter joints shall be staggered at least 12-inch from one another on the top piece. Exposed edges of the blankets shall be taped down so that the top piece is bonded to the adjacent bottom piece. The second layer shall be banded with SS bands 1.5-inch from the edges of the top pieces of the second layer. Additional bands shall be spaced 10.5-inch (for 24-inch wide) or 11.25-inch (for 48-inch wide) between the edge bands. Sufficient tension shall be applied to ensure compression between the layers but not to the extent that the insulation cut or the duct itself is distorted.

d. Vertical and horizontal members of the support hanger system shall be wrapped with one layer of the insulation. Insulation shall be secured with stainless steel banding on 6-inch to 8-inch centers. Vertical and horizontal portions shall be wrapped independent of one another. The horizontal hanger shall be removed from the vertical support rods and wrapped and then immediately replaced so that an adjacent horizontal support can be removed, wrapped, and reinstalled. The end of the threaded vertical rod shall extend 6-inch past the horizontal member at the beginning of the installation.

3. Insulation for Access Door Installation in Grease Duct:

a. External duct wrap system around the access door assembly shall be cut to allow for 1.5-inch step joints around the perimeter of the door opening. A door with a 12-inch x 12-inch opening shall have the first layer of external duct wrap cut to a size of 15-inch x 15-inch.

b. The second layer of duct wrap should be cut to a size of 18-inch x 18-inch. The exposed edges of these cut layers shall be covered with 2-mil aluminum foil tape. The first steel access door (inner) plate (16 gage or heavier) shall overlap the opening so that a 12-inch x 12-inch opening would require a 14-inch x 14-inch plate.

c. Holes shall be installed to accommodate the 6-inch long by 5/16-inch diameter steel all thread studs that are welded to the perimeter of the access door opening (at the corners and 12-inch on centers between corners). This inner steel plate shall be installed after a bead of Nelson CLK Firestop Sealant is applied around the door opening. Nuts shall be tightened to provide a good liquid tight seal between the opening and the inner access door plate.

d. Three pads of external duct wrap shall be cut to accommodate the stepped joints in the door assembly. The first step joint at 15-inch x 15-inch shall use a pad that has been cut to 15.5-inch x 15.5-inch. The next pad shall have a dimension of 18.5-inch x 18.5-inch. The final pad shall have a dimension of 21-inch x 21-inch. Each of these pads shall be impaled over the threaded studs.

e. In the first two layers the joints between the pads and duct wrap shall be equally tight. The third pad shall be placed over the second layer of duct wrap and overlap the edges by 1.5-inch around the perimeter. Second or outer plates will be cut to a size to cover the third pad. The outer plate shall be cut to 21-inch x 21-inch with holes placed in the plate to coincide with the inner plate. The outer plate shall be pushed over the studs and tightened to firmly compress the pads over the inner plate and the third pad against the outer jacket of the external duct wrap system.

4. Penetrations: Where ducts penetrate walls, floors and roofs, duct wrap shall be used in conjunction with Nelson FSP Firestop Putty. The grease duct shall be wrapped with two layers of external duct wrap though the penetration and then the annular space shall be stuffed with loose fiber or loose ceramic fiber bulk. In floor penetrations, a space 1-inch below the top of the floor shall be filled with the Nelson FSP Firestop Putty in such a way that a tight seal is obtained between the putty and the external duct wrap and also between the putty and the floor slab. In wall penetrations, a 1-inch space for the Firestop Putty shall be provided on both sides of the penetration.

G. Insulation (Type D5) application for outdoor ducts:

1. Horizontal ductwork located outdoors shall be sloped at a minimum 2-degree angle to prevent the accumulation of water on top of the finished insulated duct. Support members that connect directly to the ductwork are to be insulated with this same material. Keep compression or sharp creases of outdoor insulation to a minimum by distributing the weight of the duct resting on horizontal duct support members.

2. Follow the insulation manufacturer's installation instructions and procedures to assure the ductwork is properly insulated and that the insulation will meet the manufacturer's warranty requirements.

H. All ductwork, accessories, and all plenums including metal and masonry construction, etc., shall be insulated as indicated on the Drawings, as specified herein and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

I. Flexible ductwork connections to equipment shall not be insulated.

J. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

K. Extreme care shall be taken in insulating high and medium pressure ductwork including all ductwork between the fan discharge and all mixing boxes to ensure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these Specifications are classified as high velocity ductwork.

L. Where canvas finish is specified use lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

M. All ductwork in the Project except toilet exhaust and fume hood exhaust ductwork, shall be insulated externally unless specifically excluded.

N. Flexible round ducts shall be factory insulated.

3.03 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

Ductwork System	Application	Insulation Type	Insulation Thickness
Supply Air (Hot, Cold, Combination)	Outside of Mechanical Rooms	D1	2"
	Inside of Mechanical Rooms	D2	1-1/2"
Return, Relief Air	All	D1	1"
Outside Air	Treated and Untreated	D1	2"
Kitchen Grease Hood Exhaust Air	All	D4	2"
Supply air Diffusers	Top of diffuser	D1	2"
Supply Air Duct	Outdoor Environment	D5	1-1/2"
Return Air Duct	Outdoor Environment	D5	1-1/2"
Return Air Sound Boots/Elbows	All	D3	1"

END OF SECTION 23 07 13 00

SECTION 23 07 13 00A - SYSTEM TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by a technically qualified TAB Firm.

B. TAB Firm shall be capable of performing the TAB services as specified in accordance with the Contract Documents, including the preparation and submittal of a detailed report of the actual TAB Work performed.

C. TAB Firm shall check, adjust, and balance components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the system equipment is operating economically and efficiently. This is intended to be accomplished after the system components are installed and operating as specified in the Contract Documents. It is the responsibility of the Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC Standard, Latest Edition or NEBB Standards for Testing, Adjusting, Balancing of Environmental Systems (Latest Edition).

D. TAB Firm shall check, adjust, and balance all hydronic systems including pumps, water distribution systems, chillers, cooling towers, boilers, heat exchangers, coils, and related equipment.

E. Liaison and Early Field Inspection:

1. TAB Firm shall act as a liaison between The University, Architect and Contractor. TAB Firm shall perform the following reviews (observations) and tests:

    a. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to the ability to satisfactorily balance systems.

    b. Test at least one or at least 10 percent of the single and fan-powered terminal units if the number of units are greater than twenty (20), for casing and damper leakage when the shipment arrives at the Project Site. All testing (except for the initial terminal units) shall be performed at the Project Site.

    c. Test one (1) lab configuration including fume hood with air valve, general exhaust air with air valve and supply air with air valve for performance capability through a full range of inlet pressures. The tracking capability of the exhaust air versus the supply air will be with the submitted hood sash fully open and as the sash is closed in 2 inch increments until fully closed. Track the valves’ response time in relation to sash movement and the lab differential.

2. During the balancing process, as the TAB Firm discovers abnormalities and malfunctions of equipment or components, the TAB Firm shall advise the Contractor in writing so that the condition can be corrected by the Contractor prior to finishing the TAB scope of Work. Data from malfunctioning equipment shall not be recorded in the final TAB report.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. AABC - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
2. ASHRAE HVAC Applications Chapter 37: Testing, Adjusting and Balancing.
3. ANSI/ASHRAE Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.
4. CTI - Cooling Technology Institute CODE ATC-105.

1.04 QUALITY ASSURANCE

A. TAB Firm shall have operated a minimum of five (5) years under TAB Firm’s current name and shall be in good standing with the State of Texas, Franchise Tax Board. TAB Firm shall submit full incorporated name, Charter Number, and Taxpayer's I.D. Number for proper verification of TAB Firm's status.

B. TAB Firm’s personnel performing Work at the Project Site shall be either professional engineers or certified air and water balance technicians, who shall have been permanent, full time employees of the TAB Firm for a minimum of six (6) months prior to the start of Work for this Project.

C. TAB firm shall have a background record of at least five (5) years of specialized experience in the field of air and hydronic system balancing and shall possess properly calibrated instrumentation.

1.05 SUBMITTALS

A. The activities described in this Section shall culminate in a report to be provided in quadruplicate (4), individually bound and also provided electronically to the Contractor to be presented to The University. Neatly type and arrange data. Include with the data, the dates tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the report is to provide a reference of actual operating conditions for The University's operations personnel.

B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must have been made at the Project Site by the permanently employed technicians or engineers of the TAB Firm.

C. At The University’s option, all data sheets tabulated each day by TAB Firm personnel shall be submitted for review and sign-off by The University’s Construction Inspector. Those data sheets, as initialed by Owner’s Construction Inspector, shall be presented as a supplement to the final TAB report.

D. Submit reports on electronic forms approved by The University and Architect/Engineer which will include the following information as a minimum:

1. Title Page:
    a. Company name.

    b. Company address.
    c. Company telephone number.
    d. Project name.
    e. Project location.
    f. Project Manager.
    g. Project Engineer.
    h. Project Contractor.
    i. Project identification number.

2. Instrument List:
    a. Instrument.
    b. Manufacturer.
    c. Model.
    d. Serial number.
    e. Range.
    f. Calibration date.
    g. What test instrument was used for.
3. Fan Data (Supply and Exhaust):
    a. Identification and location.
    b. Manufacturer.
    c. Model.
    d. Air flow, specified and actual.
    e. Total static pressure (total external), specified and actual.
    f. Inlet pressure.
    g. Discharge pressure.
    h. Fan RPM.
4. Air Handler Return Air/Outside Air Data (If fans are used, provide fan data as noted above):
    a. Identification and location.
    b. Design return air flow.
    c. Actual return air flow.
    d. Design outside air flow.
    e. Return air temperature.

  - f. Outside air temperature.
  - g. Required mixed air temperature.
  - h. Actual mixed air temperature.
5. Electric Motors:
  - a. Manufacturer.
  - b. Horsepower/brake horsepower.
  - c. Phase, voltage, amperage, nameplate, actual.
  - d. RPM.
  - e. Service factor.
  - f. Starter size, heater elements, rating.
6. V-Belt Drive:
  - a. Identification and location.
  - b. Required driven RPM.
  - c. Driven sheave, diameter and RPM, manufacturer & model #.
  - d. Belt, size and quantity.
  - e. Motor sheave, diameter and RPM, manufacturer & model #.
  - f. Center-to-center distance, maximum, minimum and actual.
7. Duct Traverse:
  - a. System zone/branch.
  - b. Duct size.
  - c. Area.
  - d. Design velocity.
  - e. Design air flow.
  - f. Test velocity.
  - g. Test air flow.
  - h. Duct static pressure.
  - i. Air temperature.
  - j. Air correction factor.
8. Air Monitoring Station Data:
  - a. Identification and location. (equipment ID, manufacturer & model #)

   b. System.
   c. Size.
   d. Area.
   e. Design velocity.
   f. Design air flow.
   g. Test velocity.
   h. Test air flow.

9. Variable or Constant Volume Terminal Unit Test Sheet:
   a. Identification number.
   b. Room number/location.
   c. Terminal type (FP if fan powered) and / or (SDVV, SDCV, DDVV, DDCV), and (HWRH or ERH if reheat coil is used).
   d. Terminal size.
   e. Area factor.
   f. Design velocity.
   g. Design maximum and minimum air flow.
   h. Test (final) velocity.
   i. Test (final) maximum and minimum air flow.
   j. For DDC instrumentation: Measure and record computer readout and calibration factor at the final measurement conditions.
   k. Air dry bulb temperature at the discharge of the terminal unit.

10. Pump Data:
    a. Identification and location.
    b. Manufacturer.
    c. Size/model.
    d. Impeller size.
    e. Service (CTW, CHW, CDW, HW, etc.).
    f. Developed head pressure and BHP at design flow rate.
    g. Developed head pressure and BHP at actual flow rate.
    h. Pump discharge pressure.
    i. Pump suction pressure.
    j. Total operating head pressure at final balance.

    k. Shut off, discharge and suction pressure.
    l. Shut off, total head pressure.
    m. Pressure differential settings.
    n. Fluid temperature.

11. Cooling Coil Data:
    a. Identification number.
    b. Location.
    c. Service.
    d. Manufacturer.
    e. Entering air DB temperature, design and actual.
    f. Entering air WB temperature, design and actual.
    g. Leaving air DB temperature, design and actual.
    h. Leaving air WB temperature, design and actual.
    i. Water pressure flow, design and actual.
    j. Water pressure drop, design and actual.
    k. Entering water temperature, design and actual.
    l. Leaving water temperature, design and actual.
    m. Air quantity CFM design, and CFM actual.
    n. Air pressure drop, design and actual.
    o. Sensible Btu/hr. design, and actual.
    p. Total Btu/hr. design, and actual.
12. Heating Coil Data:
    a. Identification number.
    b. Location.
    c. Service.
    d. Manufacturer.
    e. Air flow, design and actual.
    f. Water flow (gpm) or Steam mass flow rate (lbs. per hour) design and actual.
    g. Pressure drop water (feet w.g.) or steam (psig), design and actual.
    h. Entering water or steam temperature, design and actual.

   i. Leaving water or steam temperature, design and actual.
   j. Entering air temperature, design and actual.
   k. Leaving air temperature, design and actual.
   l. Air quantity CFM design, and CFM actual.
   m. Air pressure drop, design and actual.
   n. Sensible Btu/hr. design, and actual.
   o. Electric heat kW, number of stages, kW per stage – specified and actual (if applicable).

13. Heat Exchanger Data:
   a. Identification and location.
   b. Service.
   c. Manufacturer.
   d. Steam flow rate, design and actual.
   e. Water flow rate, design and actual.
   f. Water pressure drop, design and actual.
   g. Entering steam temperature and pressure, design and actual.
   h. Entering water temperature, design and actual.
   i. Leaving water temperature, design and actual.
   j. Electric heat, full load kW, number of stages, kW per stage – specified and actual (if applicable).

14. Chiller:
   a. Identification and location.
   b. Manufacturer and model number.
   c. Condenser cooling medium (water or air cooled).
   d. Number of compressor types and number of stages.
   e. Chilled water entering and leaving temperature - specified and actual - one hour log.
   f. Condenser water entering and leaving temperature - specified and actual - one hour log.
   g. Evaporator section and condenser section water side pressure drop - specified and actual.
   h. Air cooled condenser entering and leaving dry bulb temperatures.
   i. Compressors full load amperage - specified and actual.
   j. Voltage, phase, and cycle - specified and actual.
   k. Ambient temperature, DB/WB, time of day, and weather conditions at time of test.

  l. Cooler tons, condenser tons, and measured operating kW / ton compared to factory certified performance test data.

15. Cooling Tower:
    a. Identification and location.
    b. Manufacturer.
    c. Model number.
    d. Size and serial number.
    e. Motor horsepower and RPM.
    f. Voltage, phase, hertz.
    g. Full load amps.
    h. Running amps.
    i. Cooling tower water flow rate through the tower.
    j. Cooling water flow rate through the bypass piping.
    k. Air entering and leaving dry bulb and wet bulb temperatures.
    l. Record airflow velocities and rates at the tower air inlets.
    m. Specified and actual tons capacity at design conditions.
    n. Cooling tower water temp entering and leaving.
16. Hot Water Boiler or Steam Boiler:
    a. Identification and location.
    b. Unit manufacturer and model number.
    c. Heating water flow gpm - specified and actual (if applicable).
    d. Steam capacity lbs. per hour - specified and actual (if applicable).
    e. Steam temperature and pressure - specified and actual.
    f. MBtuh Input / output - specified and actual.
    g. MBtuh output - specified and actual.
    h. Gas / Fuel oil burner CFH / gpm.
    i. Gas / Fuel oil inlet pressure, in water / psig.
    j. Blower motor horsepower and FLA .
    k. Fire rate - gas, therm. / oil, btu per lbm.
    l. High fire set point(s).
    m. Low fire set point(s).

n. NOx measurement (based on capacity of boiler per the Texas Commission on Environmental Quality). CO2, CO and O2.

17. Sound Level Report:
    a. Location (Location established by the Engineer).
    b. Baseline background NC curve for eight (8) bands – with equipment off.
    c. Operating NC curve for eight (8) bands – with equipment on.
18. Vibration Test on equipment having 10 horsepower motors or greater:
    a. Location of points:
        1) Fan bearing, drive end.
        2) Fan bearing, opposite end.
        3) Motor bearing, center (if applicable).
        4) Motor bearing, drive end.
        5) Motor bearing, opposite end.
        6) Casing (bottom or top).
        7) Casing (side).
        8) Duct after flexible connection (discharge outlet).
        9) Duct after flexible connection (suction inlet).
    b. Test readings:
        1) Horizontal, velocity and displacement.
        2) Vertical, velocity and displacement.
        3) Axial, velocity and displacement.
    c. Normally acceptable readings, velocity and acceleration.
    d. Unusual conditions at time of test.
    e. Vibration source (if non-complying).
19. Control verification indicating date performed and any abnormalities identified:
    a. Point Location/Description.
    b. EMS Readout (Setpoint and Actual).
    c. Actual Readout.
    d. Interlocks.
    e. Safeties:
        1) VSD Normal Operation.

2) VSD Bypass Operation.

f. Alarms.

g. Sequences of Operation.

20. Include in the appendix all submittals for air handling units, pumps, fans, heat exchangers, energy recovery units control system, etc.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 AIR BALANCE

A. When systems are installed and ready for operation, the TAB Firm shall perform an air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within +/- 5 percent of the value shown on the Drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the branch damper for flexible duct connected devices and the device opposed blade damper (OBD) for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown.

B. For lab renovations the entire exhaust fan riser shall be balanced.

C. For all renovations air balance data shall be noted on a set of the mechanical drawings, in addition to the required report, and shall reflect supply air at each diffuser, exhaust at each device and return air device as applicable.

D. The general scope of balancing by the TAB Firm shall include, but is not limited to, the following:

1. Filters: Check air filters and filter media and balance only systems with essentially clean filters and filter media. The Contractor shall install new filters and filter media prior to the final air balance.

2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Contractor shall make any required changes.

3. Ampere Readings: Measure and record full load amperes for motors.

4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems, which do not perform as designed.

5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM(s) and temperatures, as applicable, at each fan, blower and coil.

6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and reheat coil at each VAV terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).

7. Zone Air Flow: Adjust each HVAC VAV terminal unit and VAV air handling unit for design CFM.

8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within + 5 percent of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and rooms that are negative exhaust air flow shall be set to design + 10 percent and supply to design - 5 percent. Positive areas will have opposite tolerances.

9. Pitot Tube Traverses: For use in future troubleshooting by Owner, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.

10. Maximum and minimum air flow on terminal units.

3.02 HYDRONIC SYSTEM BALANCE

A. When systems are installed and ready for operation, the TAB Firm shall perform water balance for each chilled and heating hot water system.

B. The general scope of balancing by the TAB Firm shall include, but not be limited to, the following:

1. Adjusted System Tests: Adjust balancing valves at each coil and heat exchanger for design flow, +/- 5 percent. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve. (Note: If discharge valves on the pumps are used for balancing record the head being restricted by the valves).

2. Temperature Readings: Read and record entering and leaving water temperature at each water coil, converter and heat exchanger. Adjust as necessary to design conditions. Provide final readings at all thermometer well locations.

3. Test cooling towers in accordance with CTI Code ATC – 105.

4. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow measuring status, if provided and installed, at each air handler. The flow of water through all water coils shall be adjusted by manipulating valves until the rated pressure drops across each coil is obtained and total water flow is verified by flow measuring status. For coils equipped with 3-way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.

5. Ampere Readings: Reading and record full load amperes for each pump motor.

3.03 SOUND VIBRATION AND ALIGNMENT

A. Sound: Read and record sound levels at up to fifteen (15) locations per floor in the building as designated by the Architect/Engineer. All measurements shall be made using an Octave Band Analyzer. All tests shall be conducted when the building is quiet and in the presence of the Architect/Engineer, at the Architect/Engineer’s option.

B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which have motors larger than 10 horsepower Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as approved by the Architect/Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed one mil on fans and one mil on pumps unless otherwise specified. Equipment manufacturer shall rectify all systems exceeding vibration tolerances.

3.04 BUILDING AUTOMATION SYSTEMS

A. In the process of performing the TAB Work, the Contractor shall:

1. Work with the Building Automation System (BAS) Provider and Owner to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.
2. Verify that all control devices are properly connected.
3. Verify that the intended controllers operate all dampers, valves and other controlled devices.
4. Verify that all dampers and valves are in the position indicated by the controller; open, closed, or modulating.
5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes all duct-mounted dampers, dampers in terminal units, and fire/smoke dampers.
6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.
7. Observe the calibration and operation of all controllers.
8. Verify the proper application of all normally opened and normally closed valves.
9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. BAS Provider will relocate sensors as deemed necessary by the TAB Firm or Contractor.
11. Verify that the sequence of operation for any control mode is in accordance with approved Shop Drawings and Specifications. Verify that no demand for simultaneous heating and cooling occurs at the terminal units.
12. Verify that all controller setpoints meet the Contract Documents.
13. Check all dampers for free travel.
14. Verify the operation of all interlock systems.
15. Perform variable volume system verification to assure the system and system components track with changes from full flow to minimum flow.

3.05 STAIRWELL PRESSURIZATION SYSTEMS

A. With all doors closed, measure the door pull to determine that the opening force required is less than or no greater than 30 pound-force.

B. With all doors closed, measure the pressure differential across each door to verify the pressure differentials at each floor. Pressure differential shall not exceed 0.15 inches w.g. and shall be greater than 0.05 inches w.g.

C. Measure the airflow in the stairwell with the maximum number of doors fully open by pitot tube traverse, if traverse locations are available. If traverse locations are not available, TAB Firm shall measure air flow at each outlet.

D. Verify with smoke that the smoke detector in the stair pressurization fan inlet shuts down the fan.

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SECTION 23 11 23 00 - FACILITY NATURAL-GAS PIPING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for facility natural gas piping. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
    a. Pipes, tubes, and fittings.
    b. Piping specialties.
    c. Piping and tubing joining materials.
    d. Valves.
    e. Pressure regulators.
    f. Service meters.
    g. Mechanical sleeve seals.
    h. Grout.
    i. Concrete bases.

C. Definitions

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Performance Requirements

1. Minimum Operating-Pressure Ratings:
    a. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
    b. Service Regulators: 65 psig (450 kPa) **OR** 100 psig (690 kPa), **as directed**, minimum unless otherwise indicated.
    c. Minimum Operating Pressure of Service Meter: 5 psig (34.5 kPa) **OR** 10 psig (69 kPa) **OR** 20 psig (138 kPa) **OR** 65 psig (450 kPa), **as directed**.
2. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less **OR** More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) **OR** More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), **as directed**.

    OR

    Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) and is reduced to secondary pressure of 0.5 psig (3.45 kPa) or less.

    OR

    Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa) and is reduced to secondary pressure of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa).

    OR

    Natural-Gas System Pressures within Buildings: Three pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa) and is reduced to secondary pressures of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) and is reduced again to pressures of 0.5 psig (3.45 kPa) or less.

3. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
3. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
    a. Detail fabrication and assembly of seismic restraints.
    b. Design Calculations: Calculate requirements for selecting seismic restraints.
4. Welding certificates.
5. Field quality-control reports.
6. Operation and maintenance data.

F. Quality Assurance
1. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. All pipe, fittings, couplings, gaskets and valves shall be manufactured domestically.

G. Delivery, Storage, And Handling
1. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
2. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
3. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.
4. Protect stored PE pipes and valves from direct sunlight.

H. Project Conditions
1. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
    a. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
    b. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
    a. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
    b. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

c. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
d. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    1) Material Group: 1.1.
    2) End Connections: Threaded or butt welding to match pipe.
    3) Lapped Face: Not permitted underground.
    4) Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
    5) Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
e. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
    1) Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
f. Mechanical Couplings:
    1) Stainless-steel **OR** Steel, **as directed**, flanges and tube with epoxy finish.
    2) Buna-nitrile seals.
    3) Stainless-steel **OR** Steel, **as directed**, bolts, washers, and nuts.
    4) Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
    5) Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
    a. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
    b. Coating: PE with flame retardant.
        1) Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
            a) Flame-Spread Index: 25 or less.
            b) Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
    c. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
    d. Striker Plates: Steel, designed to protect tubing from penetrations.
    e. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
    f. Operating-Pressure Rating: 5 psig (34.5 kPa).

B. Piping Specialties
1. Appliance Flexible Connectors:
    a. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
    b. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
    c. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
    d. Corrugated stainless-steel tubing with polymer coating.
    e. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
    f. End Fittings: Zinc-coated steel.
    g. Threaded Ends: Comply with ASME B1.20.1.
    h. Maximum Length: 72 inches (1830 mm).
2. Quick-Disconnect Devices: Comply with ANSI Z21.41.
    a. Copper-alloy convenience outlet and matching plug connector.
    b. Nitrile seals.
    c. Hand operated with automatic shutoff when disconnected.
    d. For indoor or outdoor applications.
    e. Adjustable, retractable restraining cable.
3. Y-Pattern Strainers:
    a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

    - b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
    - c. Strainer Screen: 40 **OR** 60, **as directed**, -mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
    - d. CWP Rating: 125 psig (862 kPa).
  - 4. Basket Strainers:
    - a. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
    - b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
    - c. Strainer Screen: 40 **OR** 60, **as directed**, -mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
    - d. CWP Rating: 125 psig (862 kPa).
  - 5. T-Pattern Strainers:
    - a. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
    - b. End Connections: Grooved ends.
    - c. Strainer Screen: 40 **OR** 60, **as directed**, -mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
    - d. CWP Rating: 750 psig (5170 kPa).
  - 6. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

C. Joining Materials
  - 1. Joint Compound and Tape: Suitable for natural gas.
  - 2. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Manual Gas Shutoff Valves
  - 1. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
  - 2. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
    - a. CWP Rating: 125 psig (862 kPa).
    - b. Threaded Ends: Comply with ASME B1.20.1.
    - c. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
    - d. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
    - e. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
    - f. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
  - 3. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
    - a. CWP Rating: 125 psig (862 kPa).
    - b. Flanged Ends: Comply with ASME B16.5 for steel flanges.
    - c. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
    - d. Service Mark: Initials "WOG" shall be permanently marked on valve body.
  - 4. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
    - a. Body: Bronze, complying with ASTM B 584.
    - b. Ball: Chrome-plated brass.
    - c. Stem: Bronze; blowout proof.
    - d. Seats: Reinforced TFE; blowout proof.
    - e. Packing: Separate packnut with adjustable-stem packing threaded ends.

    - f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
    - g. CWP Rating: 600 psig (4140 kPa).
    - h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    - i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- 5. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
    - a. Body: Bronze, complying with ASTM B 584.
    - b. Ball: Chrome-plated bronze.
    - c. Stem: Bronze; blowout proof.
    - d. Seats: Reinforced TFE; blowout proof.
    - e. Packing: Threaded-body packnut design with adjustable-stem packing.
    - f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
    - g. CWP Rating: 600 psig (4140 kPa).
    - h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    - i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- 6. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
    - a. Body: Bronze, complying with ASTM B 584.
    - b. Ball: Chrome-plated bronze.
    - c. Stem: Bronze; blowout proof.
    - d. Seats: Reinforced TFE.
    - e. Packing: Threaded-body packnut design with adjustable-stem packing.
    - f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
    - g. CWP Rating: 600 psig (4140 kPa).
    - h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    - i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- 7. Bronze Plug Valves: MSS SP-78.
    - a. Body: Bronze, complying with ASTM B 584.
    - b. Plug: Bronze.
    - c. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
    - d. Operator: Square head or lug type with tamperproof feature where indicated.
    - e. Pressure Class: 125 psig (862 kPa).
    - f. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    - g. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- 8. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
    - a. Body: Cast iron, complying with ASTM A 126, Class B.
    - b. Plug: Bronze or nickel-plated cast iron.
    - c. Seat: Coated with thermoplastic.
    - d. Stem Seal: Compatible with natural gas.
    - e. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
    - f. Operator: Square head or lug type with tamperproof feature where indicated.
    - g. Pressure Class: 125 psig (862 kPa).
    - h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    - i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- 9. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
    - a. Body: Cast iron, complying with ASTM A 126, Class B.
    - b. Plug: Bronze or nickel-plated cast iron.
    - c. Seat: Coated with thermoplastic.
    - d. Stem Seal: Compatible with natural gas.

e. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
f. Operator: Square head or lug type with tamperproof feature where indicated.
g. Pressure Class: 125 psig (862 kPa).
h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

10. Valve Boxes:
    - a. Cast-iron, two-section box.
    - b. Top section with cover with "GAS" lettering.
    - c. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
    - d. Adjustable cast-iron extensions of length required for depth of bury.
    - e. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

E. Motorized Gas Valves
1. Automatic Gas Valves: Comply with ANSI Z21.21.
    - a. Body: Brass.
    - b. Seats and Disc: Nitrile rubber.
    - c. Springs and Valve Trim: Stainless steel.
    - d. Normally closed.
    - e. Visual position indicator.
    - f. Electrical **OR** Mechanical, **as directed**, operator for actuation by appliance automatic shutoff device.
2. Electrically Operated Valves: Comply with UL 429.
    - a. Pilot operated.
    - b. Body: Brass.
    - c. Seats and Disc: Nitrile rubber.
    - d. Springs and Valve Trim: Stainless steel.
    - e. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
    - f. NEMA ICS 6, Type 4, coil enclosure.
    - g. Normally closed.
    - h. Visual position indicator.

F. Pressure Regulators
1. General Requirements:
    - a. Single stage and suitable for natural gas.
    - b. Steel jacket and corrosion-resistant components.
    - c. Elevation compensator.
    - d. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.
2. Service Pressure Regulators: Comply with ANSI Z21.80.
    - a. Body and Diaphragm Case: Cast iron or die-cast aluminum.
    - b. Springs: Zinc-plated steel; interchangeable.
    - c. Diaphragm Plate: Zinc-plated steel.
    - d. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
    - e. Orifice: Aluminum; interchangeable.
    - f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
    - g. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
    - h. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
    - i. Overpressure Protection Device: Factory mounted on pressure regulator.

j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
k. Maximum Inlet Pressure: 100 psig (690 kPa).

3. Line Pressure Regulators: Comply with ANSI Z21.80.
    a. Body and Diaphragm Case: Cast iron or die-cast aluminum.
    b. Springs: Zinc-plated steel; interchangeable.
    c. Diaphragm Plate: Zinc-plated steel.
    d. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
    e. Orifice: Aluminum; interchangeable.
    f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
    g. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
    h. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
    i. Overpressure Protection Device: Factory mounted on pressure regulator.
    j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
    k. Maximum Inlet Pressure: 2 psig (13.8 kPa) **OR** 5 psig (34.5 kPa) **OR** 10 psig (69 kPa), **as directed**.
4. Appliance Pressure Regulators: Comply with ANSI Z21.18.
    a. Body and Diaphragm Case: Die-cast aluminum.
    b. Springs: Zinc-plated steel; interchangeable.
    c. Diaphragm Plate: Zinc-plated steel.
    d. Seat Disc: Nitrile rubber.
    e. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
    f. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
    g. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
    h. Maximum Inlet Pressure: 1 psig (6.9 kPa) **OR** 2 psig (13.8 kPa) **OR** 5 psig (34.5 kPa), **as directed**.

G. Service Meters
1. Diaphragm-Type Service Meters: Comply with ANSI B109.1 **OR** ANSI B109.2, **as directed**.
    a. Case: Die-cast aluminum.
    b. Connections: Steel threads.
    c. Diaphragm: Synthetic fabric.
    d. Diaphragm Support Bearings: Self-lubricating.
    e. Compensation: Continuous temperature and pressure, **as directed**.
    f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
    g. Meter Case and Index: Tamper resistant.
    h. Remote meter reader compatible.
    i. Maximum Inlet Pressure: 100 psig (690 kPa).
    j. Pressure Loss: Maximum 0.5-inch wg (124 Pa) **OR** 2.0-inch wg (498 Pa), **as directed**.
    k. Accuracy: Maximum plus or minus 1.0 percent.
2. Rotary-Type Service Meters: Comply with ANSI B109.3.
    a. Case: Extruded aluminum.
    b. Connection: Flange.
    c. Impellers: Polished aluminum.
    d. Rotor Bearings: Self-lubricating.
    e. Compensation: Continuous temperature and pressure, **as directed**.
    f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
    g. Tamper resistant.
    h. Remote meter reader compatible.
    i. Maximum Inlet Pressure: 100 psig (690 kPa).
    j. Accuracy: Maximum plus or minus 2.0 percent.
3. Turbine Meters: Comply with ASME MFC-4M.

  - a. Housing: Cast iron or welded steel.
  - b. Connection Threads or Flanges: Steel.
  - c. Turbine: Aluminum or plastic.
  - d. Turbine Bearings: Self-lubricating.
  - e. Compensation: Continuous temperature and pressure, **as directed**.
  - f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
  - g. Tamper resistant.
  - h. Remote meter reader compatible.
  - i. Maximum Inlet Pressure: 100 psig (690 kPa).
  - j. Accuracy: Maximum plus or minus 2.0 percent.
- 4. Service-Meter Bars:
  - a. Malleable- or cast-iron frame for supporting service meter.
  - b. Include offset swivel pipes, meter nuts with O-ring seal, and factory- or field-installed dielectric unions.
  - c. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.
- 5. Service-Meter Bypass Fittings:
  - a. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
  - b. Integral ball-check bypass valve.

H. Dielectric Fittings
- 1. Dielectric Unions:
  - a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
  - b. Combination fitting of copper alloy and ferrous materials.
  - c. Insulating materials suitable for natural gas.
  - d. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
- 2. Dielectric Flanges:
  - a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
  - b. Combination fitting of copper alloy and ferrous materials.
  - c. Insulating materials suitable for natural gas.
  - d. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
- 3. Dielectric-Flange Kits:
  - a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
  - b. Companion-flange assembly for field assembly.
  - c. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
  - d. Insulating materials suitable for natural gas.
  - e. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

I. Sleeves
- 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

J. Mechanical Sleeve Seals
- 1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
  - b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**.

c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

K. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

L. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   c. Packaging: Premixed and factory packaged.

M. Labeling And Identifying
1. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

1.3 EXECUTION

A. Preparation
1. Close equipment shutoff valves before turning off natural gas to premises or piping section.
2. Inspect natural-gas piping according to NFPA 54 **OR** the International Fuel Gas Code, **as directed**, to determine that natural-gas utilization devices are turned off in piping section affected.
3. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, requirements for prevention of accidental ignition.

B. Outdoor Piping Installation
1. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, for installation and purging of natural-gas piping.
2. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
   a. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
3. Install underground, PE, natural-gas piping according to ASTM D 2774.
4. Steel Piping with Protective Coating:
   a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

OR

Replace pipe having damaged PE coating with new pipe.

5. Copper Tubing with Protective Coating:
    a. Apply joint cover kits over tubing to cover, seal, and protect joints.
    b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
6. Install fittings for changes in direction and branch connections.
7. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
    b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
8. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
9. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
10. Install pressure gauge downstream **OR** upstream and downstream, **as directed**, from each service regulator. Pressure gauges are specified in Division 23 Section "Meters And Gauges For Hvac Piping".

C. Indoor Piping Installation

1. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, for installation and purging of natural-gas piping.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
3. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Locate valves for easy access.
8. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.
11. Install escutcheons at penetrations of interior walls, ceilings, and floors.
    a. New Piping:
        1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        2) Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

           OR

           Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
        3) Piping at Ceiling Penetrations in Finished Spaces: One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.

           OR

           Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.

        4) Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
        OR
        Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        5) Piping in Equipment Rooms: One-piece, cast-brass type.

        Piping in Equipment Rooms: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        6) Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
    b. Existing Piping:
        1) Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
        OR
        Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
        2) Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
        OR
        Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
        3) Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
        OR
        Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
        4) Piping in Equipment Rooms: Split-casting, cast-brass type.
        OR
        Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
        5) Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

12. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
13. Verify final equipment locations for roughing-in.
14. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
15. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
    a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
16. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
17. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
18. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
    a. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
    b. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic

structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

- c. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
- d. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
  - 1) Exception: Tubing passing through partitions or walls does not require striker barriers.
- e. Prohibited Locations:
  - 1) Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
  - 2) Do not install natural-gas piping in solid walls or partitions.

19. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
20. Connect branch piping from top or side of horizontal piping.
21. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
22. Do not use natural-gas piping as grounding electrode.
23. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
24. Install pressure gauge downstream **OR** upstream and downstream, **as directed**, from each line regulator. Pressure gauges are specified in Division 23 Section "Meters And Gauges For Hvac Piping".

D. Service-Meter Assembly Installation

1. Install service-meter assemblies aboveground, on concrete bases.
2. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
3. Install strainer on inlet of service-pressure regulator and meter set.
4. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
5. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
6. Install service meters downstream from pressure regulators.
7. Install metal bollards to protect meter assemblies. Comply with requirements in Division 05 Section "Metal Fabrications" for pipe bollards.

E. Valve Installation

1. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
2. Install underground valves with valve boxes.
3. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
4. Install earthquake valves aboveground outside buildings according to listing.
5. Install anode for metallic valves in underground PE piping.

F. Piping Joint Construction

1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints:
   - a. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   - b. Cut threads full and clean using sharp dies.
   - c. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   - d. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.

    - e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
  - 4. Welded Joints:
    - a. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
    - b. Bevel plain ends of steel pipe.
    - c. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
  - 5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
  - 6. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
  - 7. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
  - 8. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
    - a. Plain-End Pipe and Fittings: Use butt fusion.
    - b. Plain-End Pipe and Socket Fittings: Use socket fusion.

G. Hanger And Support Installation
  - 1. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
  - 2. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
  - 3. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
    - a. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
    - b. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
    - c. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
    - d. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
    - e. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).
  - 4. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
    - a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
    - b. NPS 1/2 and NPS 5/8 (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
    - c. NPS 3/4 and NPS 7/8 (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
    - d. NPS 1 (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).
  - 5. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
    - a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
    - b. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
    - c. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

H. Connections

1. Connect to utility's gas main according to utility's procedures and requirements.
2. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
3. Install piping adjacent to appliances to allow service and maintenance of appliances.
4. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
5. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

I. Labeling And Identifying

1. Comply with requirements in Division 23 Section "Identification For Hvac Piping And Equipment" for piping and valve identification.
   OR
   Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

J. Painting

1. Comply with requirements in Division 07 for painting interior and exterior natural-gas piping.
2. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   a. Alkyd System: MPI EXT 5.1D.
      1) Prime Coat: Alkyd anticorrosive metal primer.
      2) Intermediate Coat (for a Premium Grade system): Exterior alkyd enamel matching topcoat.
      3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
3. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   a. Latex Over Alkyd Primer System: MPI INT 5.1Q.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for a Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
   b. Alkyd System: MPI INT 5.1E.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for a Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
4. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

K. Concrete Bases

1. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
   c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

    e. Install anchor bolts to elevations required for proper attachment to supported equipment.
    f. Use 3000-psig (20.7-MPa), **unless directed otherwise**, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

L. Field Quality Control
  1. Perform tests and inspections.
  2. Tests and Inspections:
    a. Test, inspect, and purge natural gas according to NFPA 54 **OR** the International Fuel Gas Code, **as directed**, and authorities having jurisdiction.
  3. Natural-gas piping will be considered defective if it does not pass tests and inspections.
  4. Prepare test and inspection reports.

M. Outdoor Piping Schedule
  1. Underground natural-gas piping shall be one of the following:
    a. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
    b. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
    c. Annealed **OR** Drawn, **as directed**, -temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
  2. Aboveground natural-gas piping shall be one of the following:
    a. Steel pipe with malleable-iron fittings and threaded joints.
    b. Steel pipe with wrought-steel fittings and welded joints.
    c. Annealed **OR** Drawn, **as directed**, -temper copper tube with wrought-copper fittings and brazed joints.
  3. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints. Install piping embedded in concrete with no joints in concrete.
  4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

N. Indoor Piping Schedule For System Pressures Less Than 0.5 psig (3.45 kPa)
  1. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
    a. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
    b. Annealed-temper, tin-lined copper tube with flared joints and fittings.
    c. Annealed-temper, copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints.
    d. Aluminum tube with flared fittings and joints.
    e. Steel pipe with malleable-iron fittings and threaded joints.
  2. Aboveground, distribution piping shall be one of the following:
    a. Steel pipe with malleable-iron fittings and threaded joints.
    b. Steel pipe with wrought-steel fittings and welded joints.
    c. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
  3. Underground, below building, piping shall be one of the following:
    a. Steel pipe with malleable-iron fittings and threaded joints.
    b. Steel pipe with wrought-steel fittings and welded joints.
  4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
  5. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

O. Indoor Piping Schedule For System Pressures More Than 0.5 psig (3.45 kPa) And Less Than 5 psig (34.5 kPa)
  1. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:

    a. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
    b. Annealed-temper, tin-lined copper tube with flared joints and fittings.
    c. Annealed-temper, copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints.
    d. Aluminum tube with flared fittings and joints.
    e. Steel pipe with malleable-iron fittings and threaded joints.
2. Aboveground, distribution piping shall be one of the following:
    a. Steel pipe with malleable-iron fittings and threaded joints.
    b. Steel pipe with steel welding fittings and welded joints.
    c. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
3. Underground, below building, piping shall be one of the following:
    a. Steel pipe with malleable-iron fittings and threaded joints.
    b. Steel pipe with wrought-steel fittings and welded joints.
4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
5. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

P. Indoor Piping Schedule For System Pressures More Than 5 psig (34.5 kPa)
1. Aboveground Piping: Maximum operating pressure more than 5 psig (34.5 kPa).
2. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.
3. Aboveground, distribution piping shall be one of the following:
    a. Steel pipe with steel welding fittings and welded joints.
    b. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
4. Underground, below building, piping shall be one of the following:
    a. Steel pipe with malleable-iron fittings and threaded joints.
    b. Steel pipe with wrought-steel fittings and welded joints.
5. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
6. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

Q. Underground Manual Gas Shutoff Valve Schedule
1. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
2. Underground:
    a. PE valves.
    b. NPS 2 (DN 50) and Smaller: Bronze plug valves.
    c. NPS 2-1/2 (DN 65) and Larger: Cast-iron, lubricated **OR** nonlubricated, **as directed**, plug valves.

R. Aboveground Manual Gas Shutoff Valve Schedule
1. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:
    a. One-piece, bronze ball valve with bronze trim.
    b. Two-piece, full **OR** regular, **as directed**, -port, bronze ball valves with bronze trim.
    c. Bronze plug valve.
2. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
    a. Two-piece, full **OR** regular, **as directed**, -port, bronze ball valves with bronze trim.
    b. Bronze plug valve.
    c. Cast-iron, nonlubricated plug valve.
3. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
    a. One-piece, bronze ball valve with bronze trim.
    b. Two-piece, full **OR** regular, **as directed**, -port, bronze ball valves with bronze trim.

c. Bronze plug valve.

4. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be one of the following:
    a. Two-piece, full **OR** regular, **as directed**, -port, bronze ball valves with bronze trim.
    b. Bronze plug valve.
    c. Cast-iron, nonlubricated **OR** lubricated, **as directed**, plug valve.
5. Valves in branch piping for single appliance shall be one of the following:
    a. One-piece, bronze ball valve with bronze trim.
    b. Two-piece, full **OR** regular, **as directed**, -port, bronze ball valves with bronze trim.
    c. Bronze plug valve.

END OF SECTION 23 11 23 00

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SECTION 23 21 13 00 - HYDRONIC PIPING

PART 1 - GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 20 01 00 00 – Basic Fire Suppression, Plumbing, and HVAC Requirements

B. Section 20 05 20 00 – Supports and Sleeves

C. Section 20 05 50 00 – Piping and Equipment Identification

1.01 WORK INCLUDED

A. Pipe and Pipe Fittings

B. Valves

C. Heating Water Piping System

D. Chilled Water Piping System

E. Condenser Water Piping System

1.02 SCOPE OF WORK: Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with, or properly incidental to, the construction of complete HVAC piping and accessories systems as indicated on the Drawings, reasonably implied there from, or as specified herein unless specifically excluded.

1.03 RELATED WORK

A. Section 08 31 13 - Access Doors

B. Section 09 91 00 - Painting

C. Section 23 21 00 00A – Hydronic Specialties

D. Section 20 05 10 00 – Piping Expansion Compensation

E. Section 21 05 40 00 - Vibration Isolation

G. Section 23 07 10 00 - Piping Insulation

H. Section 23 21 10 00a - Hydronic Specialties

1.04 REFERENCES

A. ANSI/ASME - Boiler and Pressure Vessel Code

B. ANSI/ASME Sec 9 - Welding and Brazing Qualifications

C. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300

D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV

E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV

F. ANSI/ASME B31.9 - Building Services Piping

G. ANSI/ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

H. ANSI/AWS A5.8 - Brazing Filler Metal

I. ANSI/AWS D1.1 - Structural Welding Code

J. ANSI/AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids

K. ANSI/AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids

L. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings

M. ANSI/AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

N. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless

O. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

P. ASTM B32 - Solder Metal

Q. ASTM B88 - Seamless Copper Water Tube

R. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

S. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

T. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)

U. ASTM D2310 - Machine-Made Reinforced Thermosetting Resin Pipe

V. ASTM D2466 - Socket-Type PVC Plastic Type Fittings, Schedule 40

W. ASTM D2467 - Socket-Type PVC Plastic Type Fittings, Schedule 80

X. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) Composite-Sewer Piping

Y. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

Z. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings

AA. ASTM D2855 - Making Solvent-Cemented Joints with PVC Pipe and Fittings

BB. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.05 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9

1.06 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ANSI/ASME SEC. 9, and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/AWS D1.1.

D. All pipe, fittings, couplings, gaskets and valves shall be manufactured domestically.

1.07 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00.

B. Include data on pipe materials, pipe fittings, valves, and accessories.

C. Include welder's certification of compliance with ANSI/AWS D1.1.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.01 WALL, FLOOR AND CEILING PLATES:

A. See Section 20 01 00 00.

2.02 SLEEVES, INSERTS, AND FASTENINGS:

A. See Section 23 05 29.

2.03 UNDERGROUND PIPING (Including Chilled Water):

A. See Section 23 21 10 00a Hydronic specialties

1. Piping: Factory Pre-insulated Underground Piping.
2. Valves: Class 150.

3. Fittings: Class 150.

4. Strainers and suction diffusers: Class 150

5. Unions: Class 300.

6. Flanges: Weld neck Class 150.

2.05 CHILLED/HEATING WATER PIPING - ABOVE GROUND:

A. See Section 23 21 10 00a.

1. All piping shall be Standard Weight-black steel pipe.

2. All unions: Class 300.

3. Low Zone (0' to 150' elevation)

a. Fittings on piping 2-1/2" and larger shall be standard weight butt welding type. Flanges shall be 150# welding neck type. Standard weight Weld-O-Lets, Thread-O-Lets, and shaped nipples may be used only when take-off is 1/3 or less nominal size of main. Bushings shall not be used.

b. Fittings on piping 2" and smaller shall be Class 150 black malleable iron screw fittings. (Class 300 for unions.)

c. Valves and strainers: Class 150.

4. High Zone (150’ + elevation)

a. All fittings to be Class 300, welded construction.

b. Valves and strainers: Class 300.

5. Alternate:

a. For chilled water piping 2” and smaller: Copper tubing type L is permitted.

2.06 CONDENSING WATER:

A. See Section 23 21 10 00a

1. Piping: Schedule 40 black steel.

2. Valves: Class 150.

3. Fittings: Class 150.

4. Strainers and suction diffusers: Class 150 - See Section 23 06 20.13.

5. Unions: Class 300.

6. Flanges: Weld neck Class 150.

2.07 HEATING HOT WATER - SECONDARY:

A. See Section 23 21 10 00a.

1. Piping: Standard Weight black steel.
2. Valves: Class 150.
3. Fittings: Class 150.
4. Strainers and suction diffusers: Class 150 - See Section 23 06 20.13.
5. Unions: Class 300.
6. Flanges: Weld neck Class 150.

2.08 EQUIPMENT DRAIN PIPING:

A. All factory fabricated or field erected air conditioning units with drain pans, all centrifugal water pumps and all other items or equipment or apparatus that require drains shall be connected with drain line run with adequate slope to a floor drain or other point of discharge as shown on the Drawings. On A.C. units the drain line shall include a properly sized water-sealed trap.

B. All drain piping shall be one inch (1") size minimum or larger as may be indicated on the Drawings. Such piping shall be Type L hard copper tube. The drain piping shall be assembled with adapter tees at each change in direction. Install screw plugs in unused openings for access to rod and clean.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. After completion, fill, clean, and treat systems. Refer to Section 22 13 16. UT

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space and other work.

C. Group piping whenever practical at common elevations.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

E. Provide clearance for installation of insulation, and access to valves and fittings.

F. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 10 00 Access Doors.

G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to weld area.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 91 00.

J. Install valves with stems upright or horizontal, not inverted.

3.03 FABRICATION OF PIPE:

A. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage.

B. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site.

C. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

D. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.

E. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from lying on the ground shall be removed.

F. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

G. Procedure for Assembling Other Joints: Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.

3.04 APPLICATION

A. Grooved mechanical couplings and fasteners may be used only in accessible locations and for pump fit-up assemblies, when approved by Owner in writing.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

D. Install [ball] [butterfly] valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Install [ball] [butterfly] valves for throttling, bypass, or manual flow control services.

F. Provide spring loaded check valves on discharge of condenser water pumps.

G. Use gas plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

H. Use butterfly valves [in heating water systems] [in chilled and condenser water systems] [in heating, chilled and condenser water systems].

I. Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.

J. Use lug end butterfly valves to isolate equipment.

K. Provide 3/4 inch (20 mm) ball drain valves at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. [Pipe to nearest drain.]

3.05 PIPE PRESSURE TESTS:

A. See Section 23 00 00.

3.06 CLEANING AND FLUSHING OF WATER SYSTEMS

A. Water circulating Systems shall be thoroughly cleaned before placing in operation to rid systems of rust, dirt, piping compound, mill scale, oil, grease, any and all other material foreign to water being circulated.

B. Extreme care shall be exercised during construction to prevent dirt and other foreign matter from entering the pipe or other parts of systems. Pipe stored on the project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and dirt removed.

C. At pipe end locations a temporary bypass will be installed. Bypass shall be *same* size as the supply and return pipe. Prior to flushing the distribution system, the Contractor shall install the temporary bypass and a temporary line size strainer between the supply and return pipes. Contractor shall verify that the isolation valves are open.

D. After the temporary bypasses are installed, the Contractor shall provide and operate one pump which will cause a velocity of 10 feet per second in the main piping. Pump required will provide approximately XXX gpm at XXX' of head. This pump will be provided with a shot chemical feeder and a strainer assembly. Pump shall be connected to system at the point where piping goes into the building from the tunnel. If the pump is electric driven, rather than engine driven, the Contractor shall provide all temporary electrical disconnects, wiring, fuses, and other electrical devices that are required for safe operation.

E. Circulation will be started using the temporary pump. A non-hazardous cleaning compound (Entec 324 or approved equal) shall be added using the shot feeder until the concentration level of 20 parts per million is reached. Once this 20 parts per million concentration is reached, circulation will be maintained for 48 hours. After this period of time, the cleaning water shall be dumped to the sanitary sewer.

F. The distribution system will then be refilled with city water and circulated with continual bleed and make-up until the water is certified clean by the water treatment consultant, and accepted by The University. At the completion of this step an inhibitor shall be introduced. All waste water shall be dumped into the sanitary sewer system.

G. After the system is certified as clean, the Contractor shall close the valves. The bypass piping shall be removed as final connections to the building are accomplished.

H. During the flushing procedure, strainers shall be cleaned as often as necessary to remove debris and, in any event, all strainers shall be cleaned by physically removing the strainer screen from the body of the strainer at the end of flushing. Replace strainer basket and gasket. Contractor shall not flush through control valves, coils, etc. Contractor shall provide temporary bypasses at coils and spool pieces at control valves. Flush the coils individually wasting water to sanitary sewer. Connect coils and install control valves after flushing.

I. Test samples shall be taken at all bypass locations and all tests shall indicate that the entire system has reached a PH, conductivity, and chemical concentration 1evel as approved by The University to match present systems. Contractor shall purchase needed chemicals from Owner’s chemical treatment supplier.

J. Contractor shall provide a smaller assembly to clean and flush any miscellaneous piping that cannot be included in the initial system flush. All other criteria shall remain the same.

K. Contractor shall add inhibitor to the cleaning and flushing chemicals if, once the system is approved as clean, there is any delay in connecting the new system to the existing system. This is to prevent any corrosion after the new pipe is clean.

L. Use stainless steel nipples for all take-offs to first isolation valves on pipe sizes 2” or less. Nipple diameter shall not be smaller than ¾”.

END OF SECTION 23 21 13 00

SECTION 23 21 13 23 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install air vents, pressure gauges, thermometers, strainers, air separators, expansion tanks, relief valves, water flow measuring and balancing systems, and water flow integrating meters as indicated by the Contract Documents with supplementary items necessary for their proper installation and operation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ANSI/ASME Boilers and Pressure Vessel Code, Section VIII, Division 1 Design and Fabrication of Pressure Vessels.

1.04 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by the same manufacturer throughout.

1.05 SUBMITTALS

A. Product Data:

1. Submit Shop Drawings and product data, including component sizes, rough-in requirements, service sizes, and finishes.

2. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 GENERAL

A. No take-offs from header less than 3/4 inch.

B. Provide Stainless Steel nipples on header take-offs to isolation values on sizes 2 inch or smaller.

C. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Expansion Tanks: Bell & Gossett, Taco, C. Adamson, Woods.

B. Automatic Air Vents: Armstrong.

C. Air Separators: Bell & Gossett, Taco, P. Wood, Armstrong.

D. Water Relief Valves: Keckley, Watts, Bell & Gossett.

E. Integrating Flowmeters: Panametrics, Balance Master, Controlotron, EMCO.

F. Pressure Gauges: Ashcroft, Dwyer, Weksler, Marsh Instrument, H.O. Trerice, Moeller Instrument Co, Weiss.

G. Thermometers: Ashcroft, Dwyer, Marsh Instrument, Weksler, Moeller Instrument, H.O. Trerice, Weiss, Controlotron Corporation.

H. Pump Suction Fittings: Bell and Gossett, Taco, Victaulic.

I. Strainers: Keckley, Mueller, Muessco, Strainers, Inc., Grinnell.

2.03 EXPANSION TANKS

A. Tank Construction: Closed, welded steel, tested and stamped in accordance with Section VIII, Division 1, of ANSI/ASME Boiler and Pressure Vessel Code, 125 psig rating. Clean, prime coat, and supply with steel support saddles. Supply with renewable heavy duty butyl rubber bladder. Construct tank with tappings for installation of accessories.

B. Provide compatible/similar metals on all piping assemblies.

C. Provide with quick connect air charging valve connection (standard tire valve) tank drain.

D. Provide automatic cold water fill assembly complete with pressure relief valve, pressure reducing valve and valved bypass.

E. Set expansion tank pressure relief valve and pressure reducing valve at pressures indicated on Drawings.

F. Tank dimensions are as scheduled on Drawings.

2.04 AUTOMATIC AIR VENTS

A. Provide air vents at the highest points of the hydraulic piping systems and on the uppermost connections to all hydraulic coils; 125 psig pressure rating. Provide shutoff valves to facilitate maintenance of air vents.

B. Locate all air vents and their discharge lines in accessible locations, preferably clustered.

C. Route discharge lines to nearest floor drain without air traps.

2.05 AIR SEPARATORS

A. Steel tank, flanged inlet and outlet connections, separate top fittings for make-up line connection, automatic air vent, and bottom connection for blow-down and cleaning. ASME construction and stamped for 125 psig design pressure.

B. Provide stainless steel strainer with 3/16 inch diameter perforations and total free area of not less than five (5) times the cross sectional area of the connecting pipe.

C. Provide full port or butterfly valves for unit isolation and bypass.

D. Units shall be full line size.

E. Provide redundant units or bypass piping.

2.06 WATER RELIEF VALVES

A. Pressure relief valves installed for the protection of the water circulating circuits shall be single seated diaphragm and spring type valve with screwed connections, similar to Watts No. 174A.

B. ¾ inch size of bronze construction with bronze seat, composition shut-off disc, and rubber diaphragm.

C. For hot water systems components must be of similar metal piping.

2.07 INTEGRATING BTU METERS

A. General:

1. Engineered BTU and/or ton hour measuring systems utilizing best practices for reducing entire system error.
2. Install in main building chilled and hot water piping systems and elsewhere as shown on the Drawings.
3. Flow element shall be installed in a straight run of pipe in accordance to manufacturer’s guidelines for the specific installation in order to maintain rated accuracy.
4. Provide in writing manufacturers length straight run pipe recommendations for each meter installation, provide curves.

B. Flow Stations:

1. Provide laminated or metal identification tag on chain giving pipe size, meter series, and station identification.
2. Maximum fluid operating ranges:
    a. Pressure: 0 to 150 psig.
    b. Temperature: 32 degrees F to 250 degrees F.
3. Flow stations shall be of steel construction.

C. Portable:

1. Provide a hand-held, portable meter that instantaneously displays flow and/or changes in flow by means of a high-visibility, integral, backlit LCD, dual channel (one for chilled water, the other for steam condensate or hot water as noted on Drawings) that displays instantaneous flow rate in GPM and total gallons. Charts and tables are not acceptable.
2. Each channel shall have dual outputs for each of the displayed values. Outputs shall be 4– 20 mA and TTL pulse rate, each proportional to display values.
3. Meter shall have positive zero flow indication.
4. Meter shall be complete with adequate lengths of flow cables attached to sensors, with installation and operating instructions.

5. Meter shall be capable of interfacing with and delivering a signal to the building automation system.

2.08 FLEXIBLE HOSE

A. Must be similar metals and compatible with connected piping.

B. Install connector in a straight line without offset. Piping shall be supported so that connector does not carry pipe load.

C. Install in line without twisting connector.

D. For pipe sizes ½ inch to 2 inches only.

2.09 PRESSURE GAUGES

A. Application: Provide pressure gauges as indicated on Drawings; 2-½ inch face diameter with 0.5 percent accuracy of full span, Grade 2A, ANSI B40.1.

B. Gauge Ranges:

1. Provide 0 - 160 psi gauges for 150 psi chilled/hot water service.
2. Provide 0 – 300 psi gauges for 300 psi, chilled/hot water service.
3. Provide 0 - 200 psi gauges for domestic cold water service.
4. Provide 0 – 150 psi gauges for condenser water and generator cooling water service.
5. Provide liquid glycerin filled compound pressure gauges with a graduation ratio of 30 psi to 30 inches of mercury across basket strainer at suction of condensing water pump.

C. For each gauge, provide bronze gauge lock and globe type bleed valve:

1. Similar to Jenkins 750, Crane 362E, Stockham B-66, Powell 120 or accepted substitution of the pressure rating for the system installed.

2.10 THERMOMETERS

A. PROVIDE NO MERCURY THERMOMETERS

B. Placement: Provide, where shown on Drawings and as indicated below, thermometers of suitable range for the service required. Provide thermometers on the inlet and outlet sides of all coils, heat exchangers, and heat generators.

C. Furnish thermometers for services in the following ranges and divisions with English scales:

1. Domestic hot water:
   a. Range: 30 to 200 degrees F.
   b. Division: 1 degrees F.
2. Heating hot water and generator cooling water:
   a. Range: 30 to 240 degrees F.
   b. Division: 2 degrees F.
3. Chilled water:

a. Range: 0 to 100 degrees F.

b. Division: 1 degrees F.

4. Condenser water:

a. Range: 0 to 120 degrees F.

b. Division: 1 degrees F.

D. Thermowells: Provide thermometer thermowells at all thermometer locations. Provide thermometer thermowells only, fitted with plug and chain and conforming to the requirements specified for thermometers. Install all thermowells vertical or at a 45-degree vertical angle to permit filling with conducting liquid for tests.

E. Construction: Provide thermometers that are 9 inches long with an etched glass enclosed scale of 2-degree increments, a cast aluminum case. Furnish an adjustable, angle-type scale with a swivel nut connection into ¾-inch brass separable thermowells. Use a 3-1/2 inch stem length for all pipe sizes up through 8 inches, a 6-inch stem length for 10 inch pipe size, and a 9-inch stem length for pipe sizes larger than 10 inches.

F. Extensions: Where thermometers are installed in insulated lines, use extension-neck separable thermowells.

G. Remote Thermostats: Furnish remote bulb thermometers where specified and shown. Provide thermometers with corrosion-resistant movements set in cast aluminum cases with black enamel finish.

1. Furnish dials 4-½ inches in diameter, with black numbers on white dials.

2. Use copper capillary tubing protected by a spiral or double-braided bronze armor.

3. Single unit scales (metric or SAE) owner specified.

2.11 PUMP SUCTION STRAINER- CLOSED LOOP SYSTEM (CHILLED & HOT WATER)

A. Fitting: Angle pattern, cast iron body, flanged for over 2 inches, rated for 125 psig working pressure with inlet vanes, cylinder strainer with 3/16-inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

B. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping inside.

C. Provide mated flanges at all pump suctions.

2.12 STRAINERS-OPEN LOOP (CONDENSER WATER SYSTEM)

A. 2 inches and smaller: Screwed brass or iron body, Y pattern with 1/32 inch stainless steel perforated screen. 150 psi or 300 psi pressure rating to match system pressure.

B. 2-1/2 inches to 4 inches: Flanged iron body, Y pattern with 3/64 inch stainless steel perforated screen. 150 psi or 300 psi pressure rating to match system pressure.

C. Over 4 inches: Flanged carbon steel Y type with 3/16 inch stainless steel perforated screen. 150 psi or 300 psi pressure rating to match system pressure.

PART 3 - EXECUTION

3.01 PREPARATION

A. Flush and clean expansion tanks prior to delivery to the Project Site, and keep sealed during construction.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Support expansion tanks from building structure in accordance with manufacturer's instructions.

D. Provide automatic air vents at system high points and as indicated.

E. Provide manual air vents at entrance to all heating hot water coils, with a "cane" shaped discharge tube, positioned to permit draining to a portable receptacle.

F. For automatic air vents in above-ceiling spaces or other concealed locations, extend vent tubing to nearest drain.

G. Provide air separator on suction side of system circulation pump and connect as shown on Drawings.

H. Provide valved drain and hose connection on strainer blow down connection.

I. Provide pump suction strainer on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems. Clean all permanent strainers after circulating systems for a minimum of 48 hours at full capacity.

J. Support pump fittings with floor mounted pipe and flange supports.

K. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

L. Select system relief valve capacity so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

M. Pipe relief valve outlet as approved by engineer.

N. Pipe condensate line to nearest floor drain

O. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

P. Install all pressure gauges so that they are easily readable.

Q. Provide glycerin-filled compound pressure gauge upstream and downstream of each strainer.

R. Provide liquid glycerin-filled gauges across all pumps and air compressors of ranges indicated above. This does not include control air compressor.

S. Pressure gauges need not be furnished across in-the-line circulators. Where air compressors and receivers are for control air only, standard 2-inch instrument gauges will be acceptable. Equip stem gauges with coil siphons.

T. Utilize SS tubing no less than 3/8” diameter for control devices and metering connections. Dirt legs shall be installed prior to any tubing connection to control device or meter. Dirt leg shall have a full port ball valve for blow down.

END OF SECTION 23 21 13 23

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SECTION 23 21 16 00 - PIPING, VALVES, AND FITTINGS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Valves.

1.03 RELATED SECTIONS

A. SECTION 20 01 00 00 - BASIC FIRE SUPPRESSION, PLUMBING AND HVAC REQUIREMENTS.

B. SECTION 20 05 20 00 - SUPPORTS AND SLEEVES

C. SECTION 20 05 50 00 - PIPING AND EQUIPMENT IDENTIFICATION

D. SECTION 20 07 10 00 - PIPING INSULATION

1.04 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

A. ANSI B31.9 – Building Services Piping.

B. ASME Sec. 9 - Welding and Brazing Qualifications.

C. ASME B16.3 - Malleable Iron Threaded Fittings.

D. ASME B16.9 – Factory Made Wrought Buttwelding Fittings

E. ASME B16.18 - Cast Bronze Solder-Joint Pressure fittings.

F. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings

G. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings - DWV.

H. ASME B16.26 - Cast Bronze Fittings for Flared Copper Tubes.

I. ASTM A47 - Ferric Malleable Iron Castings.

J. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

K. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

L. ASTM B32 - Solder Metal.

M. ASTM B42 - Seamless Copper Pipe.

N. ASTM B75 - Seamless Copper Tube.

O. ASTM B88 - Seamless Copper Water Tube.

P. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.

Q. ASTM B302 - Threadless Copper Pipe (TP).

R. NCPWB - Procedure Specifications for Pipe Welding.

S. TDH - Texas Department of Health, Water System Regulations

1.05 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ASME Sec. 9**. Submit welder’s certifications prior to any shop or field fabrication. Welder’s certifications shall be current within six months of submission.**

D. Maintain one copy of each document on site.

E. All pipe, fittings, couplings, gaskets and valves shall be manufactured domestically.

1.06 SUBMITTALS

A. Product Data:

1. Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

2. Submit manufacturer's installation instructions.

1.07 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 20 01 00 00.

1.08 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 20 01 00 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.09 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum of three years documented experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 15010.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 EXTRA MATERIALS

A. Furnish under provisions of Section 20 01 00 00.

PART 2 PRODUCTS

2.01 STEEL PIPING:

A. Scope: This section applies to all piping systems providing for welded piping, fittings, and other appurtenances. Specific systems requiring welded piping include, but are not limited to: chilled water, hot water, steam, steam condensate, and fire protection systems.

B. Pipe: Unless otherwise indicated, chiller and boiler plants piping shall be Schedule 40, and underground and building piping shall be Standard weight, Grade A or B, seamless black steel pipe conforming in all details to Standard ASTM Designation A135, A106, and A53, latest revisions. Steam condensate shall be Schedule 80.

C. FITTINGS:

1. All weld fittings shall be domestic made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9, latest edition, as made by Weld Bend, Tube Turn, Hackney, or Ladish Company. Attach to only pipe with a hole for the entire length. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting is to be marked in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.

2. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Grinnell Company, Crane Company or Walworth Company manufacture (300 lb. for unions).

3. Forged steel fittings shall be domestic.

D. FABRICATION:

1. Welded piping and fittings shall be fabricated in accordance with ASME/ANSI the latest edition of Standard B31.9 –Building Services Piping may be used within buildings. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

2. Ensure complete penetration of deposited metal with base metal. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

3. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

4. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

5. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

7. In no cases shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.

8. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

E. WELD TESTING:

1. All welds are subject to inspection, visual and/or X-ray, for compliance with specifications. The University will, at The University's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by The University. The contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and retesting of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards <u>B31.9</u> due to the discovery of poor, unacceptable or rejected welds.

2. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.

2.02 COPPER PIPE

A. Copper Pipe: Piping four inches (4") and smaller shall be fabricated of Type K, hard drawn, copper pipe made of deoxidized copper (99.9% pure). This Type K copper pipe shall conform in every detail to ASTM Standard Specifications for COPPER WATER TUBE, Serial Designation B-88-66, and it shall be provided in 20 foot straight lengths. Copper pipe 4” and smaller may only be joined using non-lead-bearing solder, such as 95-5 silver or antimony solder (95 percent tin, and 5 percent silver or antimony). Copper pipe 4” and larger may be joined using roll grooved fittings.

B. Fittings: All fittings for four inch (4") and smaller water lines shall be Streamline Solder Fittings manufactured by Streamline Pipe and Fittings Division, Mueller Brass Company, or approved equal. These wrought copper fittings shall be rigid and strong with openings machined to accurate capillary fit for the pipe.

C. Lead: It is <u>forbidden</u> that lead in <u>any form</u> be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL <u>NEW</u> MATERIALS.

2.03 Stainless Steel Piping

A. Stainless steel piping, tubing and nipples shall be 316 SS.

2.04 VALVES:

A. All valves shall be located such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall be used on this project. All bronze and iron body gate and globe valves shall be the product of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.

B. All valves used in circulating systems, plumbing and steam systems (low and medium pressure) shall be Class 150 SWP. Class 300 valves shall be constructed of all ASTM B-61 composition. All gate, globe and angle valves shall be union bonnet design. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Written approvals must be secured for the use of alternative materials. <u>Alloys used in all bronze ball, gate, globe, check, or angle valves shall contain no more than 15% zinc.</u> **<u>No yellow brass valves will be allowed.</u>**

C. All iron body valves shall have the pressure containing parts constructed of ASTM designated of 126 class B iron. Stem material shall meet ASTM B16 Alloy 360 or ASTM 371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is preferred on yoke cap for maintenance lubrication of the yoke bushing.

D. All cast steel body valves shall have the pressure containing parts constructed of ASTM designation A-216-GR-WCB carbon steel. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure-temperature rating conforming to ANSI B16-34-1977. Stems shall meet ASTM designation A-186-F6 chromium stainless steel. Wedge (gate valves) may be solid or flexible type and shall meet ASTM A-182-F6 chromium stainless steel on valves from 2" to 6". Sizes 8" and larger may be A-216-WCB with forged rings or overlay equal to 182-F6. Seat ring shall be hard faced carbon steel or 13% chromium A-182-F6 stainless. Handwheels shall be A47 Grade 35018 malleable iron or Ductile Iron ASTM A536.

E. All forged steel body valves, including those for steam and condensate return systems (high and low pressure), shall have the pressure containing parts constructed of ASTM 105, Grade 2 forged carbon steel. Seat and wedges shall meet ASTM A-182-F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI B16-34 pressure-temperature rating.

F. All valves shall be repackable, under pressure, with the valve in the full open position. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

G. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year, period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked by the Contractor, at no expense to The University, with a packing material selected by The University.

H. Balancing and/or Shutoff Valves for Hot Water Systems: Two inches and smaller, three piece full port bronze body ball valve, stainless steel ball and stem. Teflon seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle, with plastic sheathed operating handle, adjustable memory stops, and shall be class 150 SWP/600 WOG, screwed pattern. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use in insulated lines. Cold water service valves shall be as above, except two piece construction. All valves 2 1/2" and larger shall be tapped full lug butterfly valves with aluminum bronze discs of ASTM B148 Alloy C955 and 316, 416, or 420 stainless steel shafts. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling. Valve must be capable of providing a bubble tight seal at 200 psi for valves up to 12" (150 psi for larger valves) when used for end of line service without requiring the installation of a blind flange on the downstream side. Liners shall be resilient material suitable for 225 °F temperature and bodies of ductile iron. Butterfly valves 8" and larger and butterfly valves used for balancing service, regardless of size, shall have heavy duty weather proof encased gear operators, with malleable iron handwheel or crank. Valves 2 1/2" through 6" shall have lever handles which can be set in interim positions between full open and full closed. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi.

I. Check Valves for Water Systems: Bronze body, 2” and smaller, bronze body regrinding disc and seat with screw-in cap. Iron body, 2 ½” and larger, bronze disc and seat or non-slam wafer type with stainless pins and springs, and bronze plate. Forges Steel lift check valves, 2” and smaller shall be bolted cap and body, screwed end connections and conform to ANSI B16.34 and pressure temperature rating.

J. Check Valves for Steam Systems: Forged valves shall be used on high pressure systems and cast valves shall be used on low pressure systems.
STEAM: Low pressure < 15 psi > High pressure.

K. Standards of Quality for Valves:

VALVE SCHEDULE						
SIZE	TYPE	SERVICE	CLASS	MANUFACTURER**		
				Milwaukee	Nibco	Stockham or as noted
2" & smaller	Gate Valve	L.P., H.P. Steam Condensate	800			Smith
2-1/2" & larger	Gate Valve	L.P. Steam Condensate	800			Smith
*2" & smaller	Ball Valve for shut-off	Domestic Cold Water Plbg. Systems Recirculating Chilled Water	150	--	T-585-70-66	Apollo 77-140
* - Requires extended stems in insulated lines with adjustable memory stop.						
*2" & larger	Ball Valve	Domestic Hot Water Plumbing Systems & Recirculating Hot Water	150	--	T-585-70-66	Apollo Apollo 77-140
* - Requires extended stems in insulated lines with adjustable memory stop.						

VALVE SCHEDULE						
SIZE	TYPE	SERVICE	CLASS	MANUFACTURER**		
				Milwaukee	Nibco	Stockham or as noted
2" & smaller	Globe, Angle & Balancing	Chilled Water, Heating Cond. Return	150	590T	T-235	B-22
2-1/2" & larger	Butterfly Valve for shutoff	Domestic Hot & Cold Water Plbg. Systems Recirculating Chilled and Heating Water	150	NE-C,NF	LD2000	DeZurik 632,L,D, RS66,6
2" & smaller	Check Valve	All Water Systems	150	510	T-433	B-345
2-1/2" & larger	Check Valve	All Water Systems	150	1400 Series	W-920-W	Stockham ‘Duo-Check’
** - OR OWNER APPROVED EQUAL.						

2.04 UNIONS:

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus. Unions in 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2" and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type equal to Epco.

C. In all water lines where the material of the pipe is changed from ferrous to copper or brass, a dielectric coupling shall be used at the transition.

2.05 FLANGES:

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Steam system flange bolts shall have a tensile strength of 105,000 psi and an elastic limit of 81,000 psi and rated at least ANSI Grade V. Other bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and rated at least ANSI Grade I.

B. Flat faced flanges shall be furnished to match 125 lb. cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

C. FLANGE GASKETS

1. Gaskets shall be placed between the flanges of all flanged joints.

2. Gaskets shall be equal to Flexitallic spiral wound, SS winding strip, graphite filler material with carbon steel outer ring.

D. Flange Bolt Installation:

1. Bolt Lubrication: Bolts shall be well lubricated with a heavy graphite and oil mixture.

2. Torque Requirements - Bolts shall be stressed to 45,000 psi.

Nominal Bolt Dia. (Inch)	Torque (Ft-Lbs.)
.25	6
.3125	12
.375	18
.4375	30
.5	45
.5625	68
.625	90
.75	150
.875	240
1.0	368
1.125	533
1.25	750
1.375	1020
1.5	1200

3. Torque shall be checked with a calibrated breaking action torque wrench on the final torque round. Bolts shall be cold and hot torqued.

4. Torque Pattern - Shall be a cross or star pattern with at least four passes. Limit each pass to 30% of full torque increases.

5. Hot Torque - Re-torque the flange bolts with system at normal operating pressure and temperature for at least four hours.

6. Inspection - Owner shall verify hot torqueing of all medium and high pressure steam flange bolts.

2.06 Flanges

A. Gaskets shall be flexatallic, spiral wound, SS graphite with carbon outer ring.

PART 3 EXECUTION

Refer to other Sections for service specific requirements.

3.01 EXAMINATION

A. Verify excavations under provisions of Section 20 01 00 00.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

I. Provide support for utility meters in accordance with requirements of utility companies.

J. Install valves with stems upright or horizontal, not inverted.

3.04 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.

B. Slope water piping and arrange to drain at low points.

END OF SECTION 23 21 16 00

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SECTION 23 22 23 13 - STEAM CONDENSATE PUMPS

1.1 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of materials for steam condensate pumps. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. This Section includes electric-driven and pressure-powered steam condensate pumps.

C. Submittals
  1. Product Data: For each type of product indicated.
  2. Shop Drawings: Include details of installation.
     a. Include wiring diagrams.
  3. Operation and maintenance data.

D. Quality Assurance
  1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  2. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Delivery, Storage, and Handling
  1. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
  2. Store steam condensate pumps in dry location.
  3. Retain protective covers for flanges and protective coatings during storage.
  4. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
  5. Comply with pump manufacturer's written rigging instructions.

1.2 PRODUCTS

A. Electric-Driven Steam Condensate Pumps
  1. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pump(s), controls, and accessories suitable for operation with steam condensate.
  2. Configuration: Simplex **OR** Duplex, **as directed**, floor-mounting pump with receiver and float switch(es); rated to pump 200 deg F (93 deg C) steam condensate.
     a. Receiver: Floor-mounting, close-grained cast iron **OR** welded steel, **as directed**; with externally adjustable float switch(es), and flange(s) for pump mounting.
     b. Pump(s): Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case ring and mechanical seal; mounted on receiver flange.
     c. Factory Wiring: Between pump(s) and float switch(es), for single external electrical connection. Fused control power transformer if voltage exceeds 230 V.
     d. Electrical **OR** Mechanical, **as directed**, pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate if the normal start level for a single pump is exceeded.
  3. Configuration: Duplex floor-mounting pump with receiver and float switches; rated to pump 210 deg F (99 deg C) steam condensate.

   a. Receiver: Floor-mounting, close-grained cast iron **OR** welded steel, **as directed**; with externally adjustable float switches and flanges for pump mounting.
   b. Pumps: Regenerative turbine, close coupled, permanently aligned, and bronze fitted; with mechanical seals and an independent pump control circuit for each pump; mounted on base or receiver flange; rated to operate with a minimum of 2 feet (6 kPa) of NPSH.
   c. Factory Wiring: Between pumps and float switches, for single external electrical connection. Fused control power transformer if voltage exceeds 230 V.
   d. Electrical **OR** Mechanical, **as directed**, pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate if the normal start level for a single pump is exceeded.
4. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 200 deg F (93 deg C) **OR** 210 deg F (99 deg C), **as directed**, steam condensate.
   a. Receiver: Floor-mounting, close-grained cast iron **OR** welded steel, **as directed**; externally adjustable float switches; with water-level gauge, steam condensate thermometer, discharge-pressure gauge for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.
   b. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
   c. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges; rated to operate with a minimum of 2 feet (6 kPa) of NPSH.
   d. Control Panel: NEMA 250, Type 1 **OR** 2 **OR** 12, **as directed**, enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
      1) Motor controller for each pump.
      2) Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
      3) Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
      4) Momentary contact "TEST" push button on cover for each pump.
      5) Numbered terminal strip.
      6) Disconnect switch.
      7) Fused transformer for control circuit.
5. Configuration: Duplex floor-mounting pump with elevated receiver, float switches, and connecting piping; rated to pump 212 deg F (100 deg C) steam condensate.
   a. Receiver: Close-grained cast iron **OR** Welded steel, **as directed**, mounted on fabricated-steel supports; externally adjustable float switches; with water-level gauge, steam condensate thermometer, pump discharge pressure gauges, bronze isolation valves between receiver and pumps, and lifting eyebolts.
   b. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
   c. Pumps: Centrifugal, close coupled, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on base below receiver; rated to operate with a minimum of 2 feet (6 kPa) of NPSH.
   d. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106; Schedule 80; seamless steel.
   e. Fittings NPS 2 (DN 50) and Smaller: ASME B16.1, Class 125 cast iron, threaded.
   f. Fittings NPS 2-1/2 (DN 65) and Larger: ASTM A 234/A 234M, steel, for welded connections.
   g. Control Panel: NEMA 250, Type 1 **OR** 2 **OR** 12, **as directed**, enclosure with hinged door and grounding lug; mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
      1) Motor controller for each pump.
      2) Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
      3) Manual lead-lag control to override electrical alternator to manually select the lead pump.

4) Momentary contact "TEST" push button on cover for each pump.
5) Numbered terminal strip.
6) Disconnect switch.
7) Fused transformer for control circuit.

6. Configuration: Underground duplex pump with basin and float switches; rated to pump 200 deg F (93 deg C) steam condensate.
   a. Basin: Cast iron, with hub-type inlets.
   b. Basin Cover: Cast iron or steel with gasketed openings for access, pumps, pump shafts, control rods, discharge piping, and vent connections.
      1) Anchor Flange: Cast iron, attached to basin, in location and of size required to anchor basin to concrete slab.
   c. Pumps: Wet-pit mounted, vertical, flexible coupled, and suspended.
      1) Casing: Cast iron with open inlet.
      2) Shaft and Bearings: Stainless-steel shaft with oil-lubricated, bronze, intermediate sleeve bearings; 48-inch (1200-mm) maximum intervals where basin depth is more than 48 inches (1200 mm); and grease-lubricated, ball-type, thrust bearings.
      3) Shaft Couplings: Flexible, capable of absorbing vibration.
      4) Seals: Mechanical; with carbon rotating ring, bearing on a ceramic seat held by a stainless-steel spring, and enclosed by a flexible bellows and gasket.
      5) Motors: Vertically mounted on cast-iron pedestal.
      6) Pump Discharge Piping: Manufacturer's standard steel or bronze pipe, unless otherwise indicated.
   d. Control Panel: NEMA 250, Type 1 **OR** 2 **OR** 12, **as directed**, enclosure with hinged door and grounding lug; mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
      1) Motor controller for each pump.
      2) Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
      3) Manual lead-lag control to override electrical alternator to manually select the lead pump.
      4) Momentary contact "TEST" push button on cover for each pump.
      5) Numbered terminal strip.
      6) Disconnect switch.
      7) Fused transformer for control circuit.

B. Pressure-Powered Steam Condensate Pumps
1. Description: Factory-fabricated, pressure-powered pumps with mechanical controls, valves, piping connections, and accessories suitable for pumping steam condensate using steam **OR** compressed air, **as directed**.
2. Configuration: Simplex **OR** Duplex, **as directed**, pump with float-operated valve control.
   a. Pump Body: Cast iron **OR** Welded steel, **as directed**.
   b. Piping Connections: Threaded; for steam condensate, operating medium, vent, and indicated accessories.
   c. Level Gauge: Glass site gauge with shutoff cocks.
   d. Valves: Manufacturer's standard check valves on inlet and outlet.
   e. Internal Parts: Stainless-steel float, springs, and actuating mechanism.
   f. Valve Seals: Replaceable from exterior.
   g. Receiver: Cast iron **OR** Welded steel, **as directed**, factory mounted on steel supports; with water-level site glass and threaded piping connections.
   h. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106; Schedule 80; seamless steel.
   i. Fittings: ASME B16.1, Class 125 cast iron, threaded.

C. Motors
1. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

1.3 EXECUTION

A. Installation

1. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
2. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
3. Support pumps and piping separately so piping is not supported by pumps.
4. Install pumps on concrete bases. Anchor pumps to bases using inserts or anchor bolts.
5. Install thermometers and pressure gauges.

B. Connections

1. Install piping adjacent to machine to allow service and maintenance.
2. Install steam supply for pressure-powered pumps as required by Division 23 Section "Steam And Condensate Heating Piping".
3. Install compressed-air supply for pressure-powered pumps as required by Division 22 Section "General-service Compressed-air Piping".
4. Install gate and check valves on inlet and outlet of pressure-powered pumps.
5. Install check valve, gate valve, and globe valve at pump discharge connections for each electric-driven pump.
6. Pipe drain to nearest floor drain for overflow and drain piping connections.
7. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.
8. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
9. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
10. Install isolation valves on pump inlets.

END OF SECTION 23 22 23 13

SECTION 23 31 13 13 - DUCTWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform Work required to provide and install ductwork, flexible duct, hangers, supports, sleeves, flashings, vent flues, and all necessary accessories as indicated in the Contract Documents. Provide any supplementary items necessary for proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASHRAE - Handbook of Fundamentals; Duct Design.
2. ASHRAE - Handbook of HVAC Systems and Equipment; Duct Construction.
3. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
4. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.
5. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
6. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
7. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
8. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
9. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
10. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
11. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment.
12. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements.
13. SMACNA – HVAC Duct Construction Standards.
14. SMACNA – Rectangular Industrial Duct Construction Standards.
15. SMACNA – Round Industrial Duct Construction Standards.

16. SMACNA – HVAC Air Duct Leakage Test Manual.
17. UL 181 - Factory-Made Air Ducts and Connectors.
18. Engineering Design Manual for Air Handling Systems, United McGill Corporation (UMC).
19. Assembly and Installation of Spiral Ducts and Fittings, UMC.
20. Engineering Report No. 132 (Spacing of Duct Hangers), UMC.
21. AWSD1.1 American Welding Society Structural Welding Code.

1.04 DEFINITIONS

A. Low Pressure

1. 2 inch W.G. Pressure Class: Ductwork systems up to 2 inch w.g. positive or negative static pressure with velocities less than or equal to 1500 fpm.

B. Medium Pressure

1. 3 inch W.G. Pressure Class: Ductwork systems over 2 inch w.g. and up to 3 inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.
2. 4 inch W.G. Pressure Class: Ductwork systems over 3 inch w.g. and up to 4 inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.
3. 6 inch W.G. Pressure Class: Ductwork systems over 4 inch w.g. and up to 6 inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.

C. High Pressure

1. 10 inch W.G. Pressure Class: Ductwork systems over 6 inch w.g. and up to 10 inch w.g. positive or negative static pressure with velocities greater than 2500 fpm.

1.05 SUBMITTALS

A. Product Data:

1. Provide the following information for each sheet metal system furnished on the Project:
   - a. System name and type.
   - b. Duct system design pressure.
   - c. Duct material.
   - d. Duct gauge.
   - e. Transverse joint methods.
   - f. Longitudinal seam type.
   - g. Sealant type.
   - h. SMACNA rectangular reinforcement type.
   - i. SMACNA intermediate reinforcement type.
   - j. SMACNA transverse reinforcement type.

B. Record Documents:

1. Submit Shop Drawings on all items of ductwork, plenums, and casings including construction details and accessories specified herein in accordance with Division 01. Ductwork construction details and materials used for duct sealant, flexible connections, etc. shall be submitted and approved prior to the fabrication of any ductwork.

2. [Option if no Shop Drawings are required: Prepare Shop Drawings for the purpose of coordination with other trades including structural, piping, plumbing, electrical, lighting, and architectural. When Shop Drawings are not required to be submitted for the Project, field sketches and shop tickets must be available to The University upon request. Changes required during construction to accommodate coordination issues will be performed at no additional cost to The University.]

3. Draw ductwork Shop Drawings on minimum 1/4 inch equal to one foot scale building floor plans and shall indicate duct sizes, material, insulation type, locations of transverse joints, fittings, ductwork bottom elevation, offsets, ductwork specialties, fire and fire/smoke dampers, and other information required for coordination with other trades. Clearly designate fire and fire/smoke partitions on the Shop Drawings. Detail Drawings for mechanical rooms and air handling unit locations shall be submitted at a minimum scale of 1/4 inch equal to one foot.

4. Coordinate with all other trades and building construction prior to submitting Shop Drawings for review. Indicate location of all supply, return, exhaust, and light fixtures from approved reflected ceiling plans on Shop Drawings.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the Project Site and store and protect products under provisions of Division 01 and Division 20.

B. Protect materials from rust both before and after installation.

1.07 WARRANTY

A. All ductwork shown on the Drawings, specified or required for the air conditioning and ventilating systems shall be constructed and erected in a first class workmanlike manner.

B. The Work shall be guaranteed for a period of one (1) year from the Project Substantial Completion date against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as approved by The University at Contractor's expense.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 APPLICATION

A. Ductwork systems shall be constructed in accordance with the following Materials as a minimum standard. Refer to Drawings for any deviation from this Table.

AIR SYSTEM	MATERIAL	MINIMUM PRESSURE CLASSIFICATION (1)
Supply and Return Systems:		
Outside air to AHU	Galvanized Steel	Medium Pressure
Single Zone FCU Supply	Galvanized Steel	Low Pressure
Single Zone AHU Supply	Galvanized Steel	Medium Pressure
Mixed Air (AHU Plenum)	Galvanized Steel	Medium Pressure
AHU Discharge/Verticle Supply Riser	Galvanized Steel	Medium Pressure
Terminal Unit Connection	Metal Flexible Duct	As Specified
Terminal Unit to Supply Air Device	Galvanized Steel	Low Pressure
Vivarium Supply Air Valve to Air Device	316L Stainless Steel (5)	Low Pressure
Return Air Device to Return Air Distribution	Galvanized Steel	Low Pressure
Return Air Distribution	Galvanized Steel	Medium Pressure
Return Air Distribution/Verticle Riser	Galvanized Steel	Medium Pressure
Ductwork in MRI rooms	Aluminum	As Specified
Exhaust systems:		
Exhaust Air Device to Exhaust Distribution	Galvanized Steel	Low Pressure
General Exhaust Riser to Fan	Galvanized Steel	Medium Pressure
Kitchen Hood Exhaust	316L Stainless Steel	Medium Pressure (3)
Dishwasher Exhaust	316L Stainless Steel	Medium Pressure
General Lab Exhaust Air Device to horizontal Distribution	Galvanized Steel	Low Pressure
Hood/Biosafety Cabinet to Horizontal Distribution	Galvanized Steel	Medium Pressure
Combination Lab and General Exhaust Horizontal Distribution (Serving General exhaust and Multiple CFH's)	Galvanized Steel	Medium Pressure (4)
Combination Lab and General Exhaust Verticle Riser	Galvanized Steel	Medium Pressure (4)
Combination Lab and General Exhaust to Filer Housing/Exhaust Plenum	Galvanized Steel	Medium Pressure (4)
Emergency Generator Exhaust	Double Wall or Black Steel	As Specified
MRI Cryogen Vents	304 Stainless Steel or 6061 Aluminum	As Specified
Vivarium Supply Exhaust Air Valve to Air Device	316 Stainless Steel (5)	Low Pressure
Washer/Autoclave	316 Stainless Steel	Low Pressure

B. Notes to Table:

1. Positive pressure unless noted otherwise in Table.
2. Air device connections may be made with insulated flexible duct as specified herein.
3. Verify minimum pressure classification per NFPA 96 requirements.
4. Applies to exhaust system for general laboratory exhaust, fume hoods, and biosafety cabinets. Refer to Drawings for construction of any additional exhaust systems.
5. Where ductwork systems are subject to routine decontamination (HPV, Clidox, etc.), provide 316L stainless steel ductwork as indicated.

C. [Note to Specifier: the above Table can be modified to suit Project requirements. If Project conditions differ from the Table, changes shall be noted on the Drawings and in the submittals.]

2.03 DUCTWORK MATERIAL AND CONSTRUCTION

A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein.

B. Ductwork shall be constructed of G-90 coated galvanized steel of ASTM A653 and A924 Standards.

C. Minimum gauge of round, oval or rectangular ductwork shall be 26 gauge per SMACNA Standards.

D. All duct sizes shown on the Drawings are clear inside dimensions. Allowance shall be made for internal lining, where specified, to provide the required free area.

E. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched) and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.

F. Except for specific duct applications specified herein, all sheet metal shall be constructed from prime galvanized steel sheets and/or coils up to 60 inches in width. Each sheet shall be stenciled with manufacturer's name and gauge.

G. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."

H. Where ducts are exposed to view (including equipment rooms) and where ducts pass through walls, floors or ceilings; furnish and install sheet metal collars around the duct.

I. Spin-in fittings shall be as specified under Section 23 33 00 – Ductwork Accessories.

J. Duct Sealing: All ductwork, regardless of system pressure classification, shall be sealed in accordance with Seal Class A, as referenced in SMACNA Standards. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.

1. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3 inches wide open weave fiberglass scrim tape. Sufficient additional sealant shall then be applied to completely embed the cloth.

2. Sealant shall be water based, latex UL 181B-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be similar to Hard Cast Iron Grip 601, Ductmate Pro Seal or Design Polymerics DP 1010.

3. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count, similar to Hardcast FS-150.

4. Sealer shall be rated by the manufacturer and shall be suitable for use at the system pressure classification of applicable ductwork.

5. Except as noted, oil or solvent-based sealants are specifically prohibited.

6. For exterior applications, “Uni-Weather” (United McGill Corporation) solvent-based sealant shall be used.

2.04 RECTANGULAR AND ROUND DUCTWORK

A. Metal gauges listed in SMACNA HVAC Duct Construction Standards, Metal and Flexible Duct, are the minimum gauges which shall be used. Select metal gauge heavy enough to withstand the physical abuse of the installation. In no case shall ductwork be less than 26 gauge per SMACNA Standards.

B. All longitudinal seams for rectangular duct shall be selected for the specified material and pressure classification. Seams shall be as referenced in SMACNA Standards.

C. Longitudinal seams in laboratory hood exhaust ducts shall be welded.

D. All transverse joints and intermediate reinforcement on rectangular duct shall be as shown in SMACNA Standards. Transverse joints shall be selected consistent with the specified pressure classification, material, and other provisions for proper assembly of ductwork.

E. Spiral round duct and fittings shall be as manufactured by United McGill Sheet Metal Company or approved equivalent. All fittings shall be factory fabricated, machine formed and welded from galvanized sheet metal.

F. Joints in spiral duct and fittings shall be assembled, suspended, sealed, and taped per manufacturer’s published assembly and installation instructions.

G. Contractor may use DUCTMATE or Ward Industries coupling system, as an option, on rectangular ductwork. The DUCTMATE or Ward Industries system shall be installed in strict accordance with manufacturer’s recommendations.

2.05 FLAT OVAL DUCTWORK AND FITTINGS

A. Oval ducts shall be spiral flat oval or welded flat oval equivalent to those of United McGill Sheet Metal Company with gauge and reinforcing as recommended by the manufacturer. Duct may be shop fabricated of completely welded construction in accordance with SMACNA Standards.

B. Oval ducts greater than 24 inch x 72 inch shall be longitudinal seam, flat oval duct, rolled, welded and provided in standard lengths of 5 and 10 feet. Transverse joints shall be factory welded or field connected with flanges or slip couplings. Duct will be fabricated from galvanized steel meeting ASTM A 527 standards.

C. Duct reinforcing angles shall be of sizes specified for same size rectangular duct. Galvanized angles shall be used where standing seams are specified for rectangular duct.

D. Oval fittings shall comply with requirements, sealing, etc., similar to that specified for round ductwork. Manifolding taps may be permitted without increasing the length of run in the branch duct system.

E. Elbows in oval ducts may be smooth long radius or 5-piece 90-degree elbows and 3-piece 45-degree elbows. Joints in sectional elbows shall be sealed as specified for duct sealing.

2.06 CONICAL BELLMOUTH FITTINGS AND TAPS

A. Conical bellmouth fittings shall be made from 26-gauge G-90 coated galvanized steel. Two-piece construction with a minimum overall length of 6 inches and factory sealed for high-pressure requirements. Average of loss coefficient for sizes 6, 8 and 10 shall be less than 0.055.

B. Provide each fitting with minimum 24-gauge damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper form rotating around shaft. Shaft shall be extended to clear insulation.

C. Provide a flange and gasket with adhesive peel-back paper for ease of application. The fittings shall be further secured by sheet metal screws spaced evenly at no more than 4 inches on center with a minimum of four (4) screws per fitting.

D. Conical bellmouth fittings shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc. or Buckley Air Products, Inc., “AIR-TITE”.

2.07 CASINGS AND PLENUMS - 2 INCH W.G. PRESSURE CLASS

A. All 2 inch w.g. pressure class casings and plenums for mixed air plenums shall be constructed in accordance with SMACNA Standards.

B. All casings shall enclose the filter and automatic dampers as shown on the Drawings. Casings shall be fabricated of galvanized sheet metal erected with three-foot center maximum standing seams reinforced with ¼-inch bars. The casing shall be stiffened on three-foot centers maximum with angle irons tack welded in place.

C. All openings to the casing shall be properly sealed to prevent any air leakage. Access doors shall be installed as indicated on the Drawings and shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches and #370 hinges that can be operated from both the inside and the outside.

D. Casings shall be anchored by the use of angle irons sealed and bolted to the curb and floor of the apparatus casing. Casings shall be tested and provided tight at a pressure of three inches water column.

E. Insulate per Section 23 07 13.

2.08 CASINGS AND PLENUMS – 6 INCH W.G. PRESSURE CLASS

A. Shall enclose filters and automatic dampers at air handling unit systems. Casings shall be constructed of cellular, standing seam panels with 3 inch deep reinforced “hat” sections as manufactured by metal deck manufacturers and as described in SMACNA Standards.

B. All openings to the casing shall be properly sealed to prevent air leakage. Install access doors for easy access to equipment. Access doors shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches that can be operated from both the inside and outside. Hinges shall be equivalent to Ventlok #370.

C. Anchor casing by the use of galvanized angle irons sealed and bolted to the curb and floor of the apparatus casing as indicated in SMACNA Standards.

D. A fan discharge diffuser plate shall be located on the fan discharge and shall be constructed of 10 gauge steel perforated plate installed in 6 inch channel iron frames (8.2#) rigidly supported to withstand the fan discharge velocity. Perforations shall be 3/8 inch (0.375 inch) staggered on 11/16 inch centers (27 percent open area). One section shall be hinged to provide an access door between the discharge side of the fan and the entering side of the coils. After fabrication of the diffuser plate, coat with rust-resistant paint. After installation, touch up diffuser plate and paint channel iron frames with rust-resistant paint.

E. Provide sufficient access openings to allow access for maintenance of all parts of the apparatus. Access door size shall be as large as feasible for the duty required.

F. Insulate per Section 23 07 13.

2.09 ELBOWS RECTANGULAR DUCTS

A. Construct elbows as follows in order of preference:

1. Long radius, unvaned elbows.
2. Short radius, single thickness vaned elbows.
3. Rectangular, double thickness vaned elbows.

B. Long radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width. Short radius elbows shall have a centerline radius of not less than one times the duct width.

C. Contractor shall have the option to substitute short radius vaned elbows but shall request the substitution at the time of submittal of Product Data.

D. Provide turning vanes in all rectangular elbows and offsets.

E. Job fabricated turning vanes, if used, shall be fabricated of the same gauge and type of material as the duct in which they are installed. Vanes must be fabricated for same angle as duct offset. Submit Shop Drawings on factory fabricated and job fabricated turning vanes.

F. All turning vanes shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks. In most cases, this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.

G. In 90-degree turns that are over 12 inches wide in the plane of the turn, provide and install double thickness vanes on integral side rails. For ducts under 12 inches in width, use single thickness vanes. The installation of the turning vanes shall be as described for single thickness vanes. On other types of turns or elbows, single thickness trailing edge vanes shall be used.

2.10 FLEXIBLE DUCT

A. Flexible duct shall be used where flexible duct connections are shown on the Drawings to air distribution devices and terminal units and as scheduled under “Ductwork System Applications.

B. Acoustical Flexible Duct to Diffusers, Grilles, and Terminal Units:

1. Maximum length 6’-0” (six feet), installed with no more than 90 degrees of bend. Where longer duct runs or more bends are necessary, provide rigid round ductwork.
2. Acoustical flexible duct shall be manufactured with an acoustically rated CPE inner film as the core fabric, mechanically locked by a corrosion-resistant galvanized steel helix.

3. Core shall be factory pre-insulated with a total thermal performance of R-4.2 or greater. Outer jacket shall be a fire retardant reinforced aluminum jacket with a perm rating not greater than 0.05 per ASTM E 96, Procedure A.
4. Duct shall be rated for a minimum positive working pressure of 10 inches w.g. and a negative working pressure of 5 inches w.g. minimum.
5. Temperature range shall be –20 degrees F to 250 degrees F.
6. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriter's Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread less than 25; smoke developed less than 50.
7. Acoustical flexible duct shall be similar to Flexmaster Type 1M for construction and acoustical performance standards.
8. For 90 degree elbows provide Flexmaster USA Flexright elbow or equal.

C. Metal Flexible Duct:

1. May be used for terminal unit connections from sheet metal ductwork where shown on the Drawings.
2. Maximum length 2’-0” (two feet), installed in straight runs only. Where longer duct runs, or direction changes are necessary, provide rigid round ductwork.
3. Duct shall be constructed of 0.005 inch thick 3003-H14 aluminum alloy in accordance with ASTM B209. Duct shall be spiral wound into a tube and spiral corrugated to provide strength and flexibility.
4. Core shall be factory pre-insulated with a total thermal performance of R-4.2 or greater. Outer jacket shall be fire retardant metalized vapor barrier jacket of fiberglass reinforced aluminum foil, with a permeance rating not greater than 0.05 per ASTM E96, Procedure A.
5. The duct shall be rated for a minimum positive and negative working pressure of 10 inch w.g.
6. Temperature range shall be –40 degrees F to 250 degrees F.
7. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriter's Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread less than 25; smoke developed less than 50.
8. Metal flexible duct shall be similar to Flexmaster triple lock Type TL-M.

2.11 STAINLESS STEEL DUCTWORK

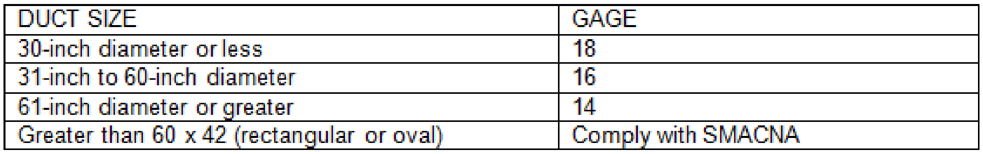
A. Applies to general laboratory exhaust, fume hood, biosafety cabinet, radioisotope hood, vivarium supply and exhaust systems subject to routine decontamination (HPV, Clidox, etc.), and moisture exhaust systems where indicated on the Drawings and as specified herein.

B. Stainless steel shall be 316-L with welded longitudinal seams and welded transverse joints. Welds on exposed ductwork shall be positioned for minimum view and shall be ground and polished. Duct sealant shall not be used to seal this ductwork.

C. All ductwork risers shall be installed as vertical as possible within the constraints of the design indicated on the Drawings. Add drains where needed.

D. In all cases, ductwork shall be installed so that the washdown water, where installed, shall drain back to the hood.

E. Metal gauges shall be not less than the following:



DUCT SIZE	GAGE
30-inch diameter or less	18
31-inch to 60-inch diameter	16
61-inch diameter or greater	14
Greater than 60 x 42 (rectangular or oval)	Comply with SMACNA

F. The joining of stainless steel ductwork with galvanized ductwork where indicated in the Drawings shall use ductwork construction methods specified herein for galvanized ductwork.

G. Connections to Air Devices Cabinets or Hoods:

1. Where approved by Owner, flexible stainless steel ducting can be used in lieu of hard pipe stainless steel at cabinets or hoods

2. For all non-insulated duct applications flexible ducting shall be 316 TI stainless steel; pressure rated for 12 inches w.g. positive and negative; UL 181, Class 0 air duct rated; Velocity Rated for 5500 fpm. Similar to Flexmaster Type SS-NI-TL.

3. For all insulated duct applications, flexible ducting shall be 316 stainless steel; pressure rated for 12 inches w.g. positive and negative; UL 181, Class 1 air duct rated; Velocity Rated for 5500 fpm. Similar to Flexmaster Type SS-TLM.

2.12 ALUMINUM DUCTWORK

A. Provide 6061 Aluminum ductwork only where indicated on the Drawings and as specified herein. Applies typically to ductwork within MRI rooms.

B. Duct joints shall be all soldered construction, one standard gauge heavier than for the same size galvanized steel ducts. Refer to SMACNA for equivalent aluminum thickness and reinforcement.

C. Construction method shall follow the specified methods for galvanized ductwork, except that no ferrous materials may be used. Only aluminum, copper and brass must be used in construction in locations requiring aluminum ductwork; this includes fasteners, hangers, anchors, etc.

D. Connections to Equipment:

1. Where approved by Owner, flexible stainless steel ducting can be used in lieu of hard pipe stainless steel.

2. Flexible ducting shall be 316 TI stainless steel; pressure rated for 12 inches w.g. positive and negative; UL 181, Class 0 air duct rated; Velocity Rated for 5500 fpm. Similar to Flexmaster Type SS-NL-TL.

2.13 KITCHEN HOOD EXHAUST

A. Stainless steel with liquid tight welded longitudinal seams and transverse joints, as specified under “Stainless Steel Ductwork” and as further specified herein.

B. Construction shall be in accordance with NFPA 96 and applicable SMACNA Standards.

C. Slope duct toward hood connections and cleanout points as shown on the Drawings.

D. No turning vanes, dampers, or other interior intrusions shall be installed in the ductwork system.

E. All changes in direction shall be with radius elbows (centerline radius equal 1.5 x duct width).

F. Provide rated access doors for installation by the Contractor at all locations necessary.

G. Coordinate required rated enclosure of kitchen hood exhaust and access points with the Contractor.

H. Manufactured double wall duct systems with NFPA certification for grease systems may be used in lieu of above referenced materials.

2.14 CAGE AND RACK WASHER EXHAUST SYSTEMS (AUTOCLAVE)

A. Stainless steel with liquid tight welded longitudinal seams and transverse joints, as specified under 2.11 “Stainless Steel Ductwork” and as further specified herein.

B. Construction shall be in accordance with NFPA 96 and applicable SMACNA Standards.

C. Slope duct toward equipment connections and cleanout points as shown on the Drawings.

D. No turning vanes, dampers, or other interior intrusions shall be installed in the ductwork system.

E. All changes in direction shall be with radius elbows (centerline radius equal 1.5 x duct width).

F. Provide rated access doors for installation by the Contractor at all locations necessary

G. Provide drains at low points and as required.

2.15 MRI CRYOGEN VENT PIPE

A. For cryogenic venting, welded stainless steel or aluminum pipe shall be used in all MRI or similar rooms where shown on the Drawings.

B. Stainless steel pipe shall be Type 304 non-ferromagnetic, thickness 0.035 inch minimum and 0.125 inch maximum.

C. Aluminum pipe shall be Type 6061-T6, thickness 0.083 inch minimum and 0.125 maximum.

D. Piping shall be installed with bracing as required to withstand the forces encountered during a cryogenic release event.

2.16 EMERGENCY GENERATOR EXHAUST SYSTEMS

A. Selkirk Metalbestos (Model IPS-C2) Minimum standard weight black steel pipe with calcium silicate insulation is acceptable in lieu of double wall system specified herein.

B. Factory-built modular exhaust system and published skin temperatures shall be laboratory tested and listed by Underwriters Laboratories, Inc., for use with building heating equipment and appliances which produce exhaust flue gases at temperature not exceeding 1400 degrees F under continuous operating conditions. This exhaust system shall be designed to compensate for all flue gas induced thermal expansions.

C. Exhaust system shall be double wall and have an outer jacket of Type 316 stainless steel, 0.025 inch thick in 6 inch through 24 inch diameter and 0.034 inch thick for larger diameter duct. The inner flue gas carrying conduit shall be Type 316 stainless steel. The inner liner shall be 0.035 inch nominal thickness for all duct diameters.

D. To control the venting pressure should a backfire occur, an explosion relief valve shall be incorporated in the exhaust system per NFPA 37.

E. Fiber insulated exhaust system shall have a fiber insulation between the walls of 2 inches thick. Asbestos materials may not be used.

F. Inner pipe joints shall be sealed by use of overlapping type V-band (P-OVB) with a premixed 200 degrees F sealant (P-200E). The outer channel bands shall be sealed with a 600 degrees F sealant (P-600) where exposed to weather.

G. When the engine exhaust system is installed according to the manufacturer's installation instructions and the limits of its listing, it shall comply with National Safety Standards and Building Codes.

H. Exhaust system shall terminate as shown on the Drawings and per NFPA 37 and NFPA 211

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Cleanliness:

1. Before installing ductwork, wipe ductwork to a visibly clean condition.
2. During construction, provide temporary closures of metal or taped polyethylene on open ductwork and duct taps to prevent construction dust or contaminants from entering ductwork system. Seal ends of ductwork prior to installation to keep ductwork interior clean. Remove closures only for installation of the next duct section.
3. For ductwork supplying Clean Rooms, Operating Rooms and other Critical Care areas, sanitize ductwork with a biocidal agent EPA approved for HVAC systems immediately prior to sealing ductwork.
4. During duration of construction, maintain the integrity of all temporary closures until air systems are activated.

D. Provide openings in ductwork where required to accommodate thermometers, controllers and other devices. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring. Sleeve of pitot tube opening shall be no more than one inch long. Opening shall be one inch wide to accept pitot tube.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Slope underground ducts to plenums or low pump out points at 1:500. Provide access doors for inspection.

G. Coat buried, metal ductwork without factory jacket with one coat and seams and joints with additional coat of asphalt base protective coating.

H. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

I. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout. Use stainless steel for ductwork exposed to view and stainless steel for ducts where concealed.

J. All visible welds in ductwork between biosafety cabinets, canopy hoods and fume hoods and the ceiling shall be ground and polished.

K. Slope duct toward grilles for moisture-laden ducts. Provide drain and trap at elbow of main moisture exhaust duct system.

L. Flexible Duct:

1. The terminal ends of the duct core shall be secured by compression coupling or stainless steel worm gear type clamp.

2. Fittings on terminal units and on sheet metal duct shall have flexible duct core slipped over duct and coupling or clamp tightened, then connection sealed with sealant. Insulation of flexible duct shall be slipped over connection to point where insulation abuts terminal unit or insulation on duct.

3. These insulation connections shall be sealed by embedding fiberglass tape in the sealant and coating with more sealant to provide a vapor barrier.

4. For 90 degree elbows use Flexmaster USA FlexRight Elbow or approved equal.

M. Support flexible ducts as per SMACNA standards to prevent sags, kinks and to have 90 degree turns.

N. Hangers and Supports:

1. All ductwork supports shall be in accordance with Table 4-1 (rectangular duct) and Table 4-2 (round duct) of the SMACNA Standards, with all supports directly anchored to the building structure.

2. Rectangular duct shall have at least one pair of supports on minimum 8’-0" (eight feet) centers. All horizontal round and flat oval ducts shall have ducts hangers spaced 10’-0" (ten feet) maximum.

3. Lower attachment of hanger to duct shall be in accordance with Table 4-4 of the SMACNA Standards.

4. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2 inch x 1-1/2 inch x 1/4 inch angles for duct widths up to 60 inches. Above 60 inches in width, the angles must be increased in strength and sized on an individual basis considering space requirements.

5. Hanger straps on duct widths 60 inches and under shall lap under the duct a minimum of 1 inch and have minimum of one fastening screw on the bottom and two on the sides.

6. Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8 inch bolts minimum.

3.02 DUCTWORK SYSTEM CLEANING

A. If the system has been operated without scheduled filters or if the integrity of temporary closures has been compromised, Contractor shall have ductwork cleaned according to National Air Duct Cleaners Association (NADCA) Standards by a Certified Regular Member of the NADCA.

1. For ductwork supplying Clean Rooms or patient care areas, also sanitize the ductwork interior per NADCA standards with a biocidal agent approved by the EPA for use in HVAC Systems.

B. Before turning the installation over to The University, Contractor shall certify that the air handling systems have only been operated with scheduled filters in place. Otherwise, Contractor shall present evidence that the ductwork was cleaned as required above.

3.03 TESTING

A. All medium and high pressure duct systems (positive or negative) shall be pressure tested according to SMACNA test procedures (HVAC Air Duct Leakage Test Manual). Notify Owner minimum seven (7) calendar days in advance of leakage testing.

1. Design pressure for testing ductwork shall be determined from the maximum pressure generated by the fan at the nominal motor horsepower selected.

2. Total allowable leakage shall not exceed 1 percent of the total system design airflow rate.

3. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.

4. Leaks identified during leakage testing shall be repaired by:

    a. Complete removal of the sealing materials.

    b. Thorough cleaning of the joint surfaces.

    c. Installation of multiple layers of sealing materials.

5. The entire ductwork system shall be tested, excluding connections upstream of the terminal units (i.e. ductwork shall be capped immediately prior to the terminal units, and tested as described above).

6. After testing has proven that ductwork is installed and performs as specified, the terminal units shall be connected to ductwork and connections sealed with extra care. Contractor shall inform The University when joints may be visually inspected for voids, splits, or improper sealing of the joints. If any leakage exists in the terminal unit connections/joints after the systems have been put into service, leaks shall be repaired as specified for other leaks.

B. All low-pressure duct systems (positive or negative) shall be inspected for visible and audible signs of leakage.

1. Leaks identified by inspection shall be repaired by:

    a. Complete removal of the sealing materials.

    b. Thorough cleaning of the joint surfaces.

    c. Installation of multiple layers of sealing materials.

2. Discrepancies found during testing and balancing between duct traverses and diffuser/grille readings shall result in re-inspection, repair and retest until discrepancies are eliminated.

C. [At the option of The University, if documented in writing, Contractor may be allowed to eliminate testing of terminal units by capping the supply ductwork prior to the terminal units, then inspecting the connection to the terminal units when complete. This option may only be exercised by The University, only if documented in writing prior to testing.]

D. Ductwork leakage testing and/or inspection shall be performed prior to installation of external ductwork insulation.

END OF SECTION 23 31 13 13

SECTION 23 31 13 33 - DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install the following ductwork accessories indicated by the Contract Documents with supplementary items necessary for proper installation.

1. Airflow control dampers and spin-in fittings.
2. Fire dampers, smoke dampers, and combination fire and smoke dampers.
3. Flexible duct connections.
4. Duct access doors.
5. Screens
6. Duct test holes.
7. Guy wire systems.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. AMCA 500D – Laboratory Method of Testing Dampers for Rating.
2. AMCA 500L – Laboratory Method of Testing Louvers for Rating.
3. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
4. NFPA 101 - Life Safety Code.
5. SMACNA - HVAC Duct Construction Standards.
6. UL 33 - Heat Responsive Links for Fire-Protection Service.
7. UL 555 – Standard for Fire Dampers.
8. UL 555C – Standard for Ceiling Dampers.
9. UL 555S – Standard for Smoke Dampers.

1.04 SUBMITTALS

A. Product Data:

1. Provide product data for shop fabricated assemblies including, but not limited to, volume control dampers, duct access doors, and duct test holes. Provide product data for hardware used.

B. Record Documents:

1. Fire Dampers: The damper manufacturer’s literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500D standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05-inch water gauge.

2. Combination Fire/Smoke Dampers: Assign identification numbers for each damper with corresponding number noted on Drawings. Provide air quantity, size, free area of damper, pressure drop and proposed velocity through each damper. Provide manufacturer’s data of damper and its accessories or options. At Owner’s request, provide two (2) dampers (18 inch x 12 inch) for the purpose of illustrating damper operation to Owner’s operating and maintenance personnel.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Dampers:

1. Greenheck.

2. Nailor Industries.

3. Ruskin.

B. Regulators, Locking Quadrants:

1. Ventfabrics.

2.03 AIR FLOW CONTROL DAMPERS

A. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of airflow, including all supply, return, outside air, and exhaust branches, "division" in main supply, return and exhaust ducts, and each individual air supply outlet. Where access to dampers through a permanent suspended ceiling (gypsum board) is necessary, the Contractor shall be responsible for the proper location of the access doors.

B. Dampers larger than three (3) square feet in area shall be controlled by a self-locking splitter damper assembly.

C. Volume damper blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16 gauge galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.

D. Volume dampers and other manual dampers shall be carefully fitted, and shall be manually controlled by damper regulators as follows:

1. On exposed uninsulated ductwork the locking quadrant shall be made with a base plate of 16-gauge cold-rolled steel and a heavy die cast handle designed with a 3/8 inch bearing surface. A 1/4 inch-20 zinc plated wing nut shall firmly lock the handle in place.

2. On exposed externally insulated ductwork the regulator shall be 4-1/4 inch diameter, for 1/2 inch rod, designed for use on duct with insulation thickness specified for duct, and shall have four (4) 3/16 inch holes provided to rivet or screw regulator to the duct surface. The flange that covers the raw edge of the insulation shall be high enough so that it slightly compresses the insulation and holds insulation in place. The handle shall be 3/8 inch above the flange, and shall easily turn without roughing up the insulation.

3. On concealed ductwork above inaccessible ceilings, the regulator shall be 2-5/8 inch diameter chromium plated cover plate that telescopes into the base, for 1/2 inch rod. Regulator shall be cast into a box for mounting in ceilings. Base shall be 1-1/2 inch deep. The cover shall be secured by two screws that can be easily removed for damper adjustment.

4. Furnish and install end bearings for the damper rods on the end opposite the quadrant.

E. Duct taps to air devices and shall include dampers on all duct to air devices (diffusers and grilles) even though a volume damper is specified for the air device. Spin-in fittings shall be similar to Flexmaster STOD, nylon bushings, locking quadrant similar to Duro Dyne KR-3, and a 3/8 inch square rod connected to the damper with U-bolts. Fittings shall be sealed at the duct tap with sealant as specified herein. Determine location of spin-in fittings after terminal units are hung or after location of light fixtures are confirmed to minimize flexible duct lengths and sharp bends.

2.04 FIRE DAMPERS

A. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555, latest edition. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating, 160 or 165 degrees F fusible link, and shall bear a U.L. label in accordance with Underwriters' Laboratories labeling procedures. Construct fire dampers such that damper frame material and curtain material are galvanized.

B. Fire dampers shall be curtain blade type and damper shall be constructed so that the blades are out of the air stream to provide 100 percent free area of duct in which the damper is housed.

C. Equip fire dampers for vertical or horizontal installation as required by location shown on Drawings. Install fire dampers in wall and floor openings utilizing steel sleeves, angles and other material and practices as required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be minimum 1-1/2 inch by 1-1/2 inch by 14 gauge and bolted, tack welded or screwed to the sleeve at maximum spacing of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the duct gauge as defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6 inch water gauge static pressure.

D. All fire dampers shall be dynamic rated type.

E. Completely seal the damper assembly to the building components using manufacturer recommended material(s).

2.05 COMBINATION FIRE/SMOKE DAMPERS

A. Provide one damper motor for each 12 square feet of damper area.

B. Each combination fire/smoke damper shall be 1-1/2 hour fire rated under UL Standard 555, Current Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S and bear a UL label attesting to same. Damper manufacturer shall have tested and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than Leakage Class II (4 CFM per square foot at one-inch water gauge pressure and 8 CFM per square foot at 4 inches water gauge pressure). Maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10-inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.) All ratings shall be dynamic.

C. Damper frame shall be minimum 20-gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. Dampers may be either parallel or opposed blade type. Blades shall be constructed with a minimum of 14-gauge equivalent thickness. Blade edge seal material shall be able to withstand 450 degrees F. Jamb seals shall be flexible stainless steel compression type or lap seal type.

D. In addition to the leakage ratings specified herein, combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. Damper and operator shall be supplied as a single entity that meets all applicable UL555 and UL555S qualifications for both dampers and operators. Manufacturer shall provide a factory-assembled sleeve. Sleeve shall be minimum 20-gauge for dampers where neither width nor height exceeds 48 inches or 16-gauge where either dimension equals or exceeds 48 inches.

E. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures at least 4 inches water gauge in the closed position, and 2500 fpm air velocity in the open position.

F. Each combination fire/smoke damper, except as noted hereinafter, shall be equipped with a UL Classified firestat/releasing device. The firestat/releasing device shall electrically (24 VAC) and mechanically (pneumatically) lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. Damper must be operable while the temperature is above 350 degrees F. Actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm system, and remote indicating/control stations or building automation system (BAS).

G. Damper releasing device shall be mounted within the airstream. Device shall be activated, and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.

H. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this Specification. Furnish all required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system.

I. Furnish each damper in a square or rectangular configuration. Furnish and install sleeves manufactured by the approved damper manufacturer for each damper. Construct sleeves with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturer's U.L. installation instructions. The entire assembly, following installation, shall operate smoothly and be capable of withstanding 6 inch water gauge static pressure.

J. All combination fire/smoke dampers shall be dynamic type.

K. Completely seal the damper assembly to the building components using manufacturer recommended material(s).

2.06 SMOKE DAMPERS

A. Provide one damper motor for each 12 square feet of damper area.

B. Each smoke damper shall be dynamic rated type and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. Leakage rating under UL555S shall be no higher than Leakage Class II (4 CFM per square foot at one-inch water gauge pressure and 8 CFM per square foot at 4 inches water gauge pressure). Maximum air pressure drop through each smoke damper shall not exceed 0.10-inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.) All ratings shall be dynamic.

C. Damper frame shall be minimum 0.125-inch aluminum formed into a structural hat channel shape with corner braces for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be stainless steel sleeve type turning in an extruded hole in the frame or an extruded frame raceway. Dampers shall be opposed blade type. Blades shall be airfoil shaped double skin construction. Blade edge seal material shall be silicone rubber designed to withstand 450 degrees F. Jamb seals shall be aluminum flexible metal compression type.

D. In addition to the leakage ratings specified herein, smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Pneumatic operators shall be installed by the damper manufacturer at the time of damper fabrication. Damper and operator shall be supplied as a single entity that meets all applicable UL555 and UL555S qualifications for both dampers and operators. Manufacturer shall provide factory-assembled sleeve. Sleeve shall be minimum 21-gauge for dampers where neither width nor heights exceeds 48 inches or 16-gauge where either dimensions equals or exceeds 48 inches.

E. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gauge in the closed position, and 2000 fpm air velocity in the open position.

F. The damper must be operable while the temperature is above 350 degrees F. The actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. Position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations (BAS).

G. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed by the damper manufacturer as required by the UL rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this Specification. Furnish all required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system.

H. Furnish each damper in a square or rectangular configuration. Furnish and install sleeves manufactured by the approved damper manufacturer for each damper. Construct sleeves with square or rectangular to square, rectangular, round, or oval adapters as required. Install dampers in the sleeves in accordance with manufacturer’s UL installation instructions. Entire assembly, following installation, shall operate smoothly and be capable of withstand 6 inch water gauge static pressure.

I. All smoke dampers shall be dynamic type.

J. Completely seal the damper assembly to the building components.

2.07 FLEXIBLE CONNECTIONS

A. Where ducts connect to fans, including roof mounted exhaust fans, or at MRI cryogenic vent connections, flexible connections shall be made using “Flexmaster TL-M” or “Ventglas” fabric that is temperature-resistant, fire-resistant, waterproof, mildew-resistant and practically airtight, weighing approximately thirty ounces (30 oz.) per square yard.

B. Material used outdoors shall be resistant to ultra-violet sunrays. There shall be a minimum of one-half inch (1/2-inch) slack in the connections, and a minimum of two and one-half inches (2-1/2-inch) distance between the edges of the ducts. This does not apply to air handling units with internal isolation.

2.08 ACCESS DOORS

A. Furnish and install in the ductwork, hinged rectangular, pressure relief, or round "spin-in" access doors to provide access to all fire dampers, mixed air plenums, steam reheat coils (install upstream), automatic dampers, etc.

B. Where ductwork is insulated, access doors shall be double skin doors with one inch (1") of insulation in the door.

C. Where duct size permits, doors shall be eighteen inches (18") by sixteen inches (16"), or eighteen inches in diameter, and shall be provided with Ventlok No. 260 latches (latches are not required in round doors).

D. Latches for rectangular doors smaller than 18 inch x 16 inch shall be Ventlok No. 100 or 140.

E. Doors for zone heating coils shall be Ventlok, stamped, insulated access doors, minimum 10 inch x 12 inch, complete with latch and two (2) hinges, or twelve inches (12") in diameter.

F. Round access doors shall be "Inspector Series" spin-in type door as manufactured by Flexmaster USA.

G. Doors for personnel access to ductwork shall be nominal twenty-four inches (24") in diameter. Doors may be fabricated in a local approved sheet metal shop in accordance with SMACNA Standards.

H. Where access doors are installed above a suspended ceiling, this Contractor shall be responsible for the proper location of ceiling access doors.

2.09 SCREENS

A. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are located outdoors.

B. Screens shall be No. 16 gauge, one-half inch (1/2") mesh in removable galvanized steel frame.

C. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

2.10 GUY WIRE SYSTEM

A. Provide 1/4-inch diameter American Aircraft Steel Cable (plastic coated) with clip for vertical stack off utility fans on roof, with eyebolts for attachment to anchor systems on the roof.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.

D. Provide all dampers furnished by the BAS Provider in strict accordance with manufacturer’s written installation instruction and requirements of these Specifications.

E. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Provide backdraft dampers on exhaust fans or exhausts ducts where indicated. Install dampers so that they will open freely.

G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps.

H. Provide duct access doors for inspection and cleaning before and after duct mounted filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated on Drawings. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated.

I. Provide duct test holes where indicated and where required for testing and balancing purposes.

1. Furnish and install Ventlok No. 699 instrument test holes in the return air duct and in the discharge duct of each fan unit.

2. Install test holes in locations as required to measure pressure drops across each item in the system, e.g., outside air louvers, filters, fans, coils, intermediate points in duct runs, etc.

J. Access doors as specified elsewhere shall be provided for access to all parts of the fire and combination fire and smoke dampers. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.

K. Install each fire and combination fire and smoke damper square and true to the building. The installation shall not place pressure on the damper frame, but shall enclose the damper as required by UL555 and UL555S.

3.02 TESTING

A. After each fire damper, smoke damper and combination fire and smoke damper has been installed and sealed in their prescribed openings and prior to installation of ceilings, Contractor shall, as approved by Owner, activate part or all dampers as required to verify “first-time” closure.

B. Activation of damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fire damper fusible link, and manually operating the fire/smoke damper through the pneumatic or electronic controls as appropriate.

C. Failure of damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.

D. Coordinate smoke damper system interlock requirements with the fire alarm system.

END OF SECTION 23 31 13 33

SECTION 23 34 19 00 - HIGH PLUME LABORATORY EXHAUST SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED

A. High-Plume Laboratory Exhaust System

1.2 RELATED WORK

A. All sections, drawing plans, specifications and contract documents.

1.3 REFERENCES

A. AMCA Publication 99, "Standards Handbook”
B. ANSI/AMCA Standard 210-99, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"
C. AMCA Publication 211-05, "Certified Ratings Programme - Product Rating Manual for Fan Air Performance"
D. AMCA Standard 300-96, "Reverberant Room Method for Sound Testing of Fans"
E. AMCA Publication 311-05, "Certified Ratings Programme"
F. AMBA Method of Evaluating Load Ratings of Bearings ANSI-11 (r1999)
G. ANSI/AMCA Standard 204-96, "Balance Quality and Vibration Levels for Fans"
H. AMCA Standard 500-D-98, "Laboratory Methods of Testing Dampers For Rating"
I. AMCA Standard 500-L-99, "Laboratory Methods of Testing Louvers For Rating"
J. SMACNA - Medium Pressure Plenum Construction Standard
K. ANSI Z9.5 – Laboratory Design
L. ASHRAE - Laboratory Design Guide

1.4 QUALITY ASSURANCE

A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with AMCA 211 and 311 in an AMCA accredited laboratory and certified for sound and air performance. Fan shall be licensed to bear the AMCA ratings seal for both sound and air performance.
B. Classification for Spark Resistant Construction conform to AMCA 99.
C. Each fan shall be vibration tested before shipping, as an assembly, in accordance with AMCA 204-05. Each assembled fan shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in three planes - horizontal, vertical, and axial. The maximum allowable fan vibration shall be less than 0.15 in./sec peak velocity; filter-in reading as measured at the fan RPM. This report shall be provided in the O&M documentation.
D. Laboratory exhaust system defined in this section shall have a 12 month warranty from the date of shipment.

1.5 SUBMITTALS

A. Provide dimensional drawings and product data on each high-plume laboratory exhaust fan assembly.
B. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
C. Provide nozzle velocity of exhaust fan, total exhaust flow, and discharge plume height at specified wind velocity.
D. Strictly adhere to QUALITY ASSURANCE requirements, as stated in section 1.4.
E. Provide a complete installation manual detailing requirements of installation.
F. Provide a complete Operations and Maintenance manual describing regular/routine maintenance recommendations, and procedures for repair or replacement of all serviceable components.

PART 2 EQUIPMENT

2.1 GENERAL

A. Base fan performance at standard conditions (density 0.075 Lb./ft^3).
B. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
C. Manufacturer: Greenheck or approved equal.
D. Fans to be equipped with 316 stainless steel lifting lugs for corrosion resistance.

E. Fasteners exposed to corrosive exhaust shall be stainless steel.
F. Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guy wires.

2.15 CORROSION RESISTANT COATING

A. All fan and system components (fan, nozzle, wind band, plenum) shall be corrosion resistant coated with LabCoat™, a two part electrostatically applied and baked, sustainable, corrosion resistant coating system; or Heresite P-413C. Standard finish color to be gray.

All parts shall be cleaned and chemically prepared for coating using a multi-stage wash system which includes acid pickling that removes oxide, increases surface area, and improves coating bond to the substrate.

The first powder coat applied over the prepared surface shall be a zinc rich epoxy primer (no less than 70% zinc) and heated to a gelatinous consistency (partial cure) at which the second powder coat of polyester resin shall be electrostatically applied and simultaneously be cured at a uniform temperature of 400°F.

The coating system, a total thickness of up to 6 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 hour ASTM B117 Salt Spray Resistance and must have a 30% gloss retention and no more than a 5 Delta E change after 5 yrs. to meet an AAMA 2604 specification.

Manually applied coatings shall not be acceptable.

2.2 FAN HOUSING AND OUTLET

A. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
B. Fan housing shall be welded steel and meet specification section 2.15 for corrosion resistant coating. No uncoated metal fan parts shall be acceptable.
C. Fan housings that are fabricated of materials that have lower mechanical properties than steel, have rough interior surfaces in which corrosive, hazardous compounds can collect, and / or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.
D. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
E. Provide housing drain for removal of rain and condensation.
F. A bolted and gasketed access door shall be supplied in the fan housing allowing for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.
G. Standard finish color to be gray.

2.3 FAN IMPELLER

A. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.
B. Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant), fully welded and meet specification section 2.15 for corrosion resistant coating.

2.4 FAN BYPASS AIR PLENUM

A. A bypass air plenum shall be provided as shown on drawings. The plenum shall be equipped with a bypass air damper and intake air hood with bird screen for introducing outside air at roof level upstream of the fan.
B. The plenum shall be constructed of fully welded steel, meet specification section 2.15 for corrosion resistant coating, and mount on roof curb as shown on the project drawings. Plenums that are fabricated of materials that have mechanical properties less than steel shall not be acceptable.
C. Plenum shall be constructed with a solid steel floor welded into the bottom. Plenum shall be designed for side intake, and shall not expose the building roof to the airstream, or negative pressure created in the bypass plenum.
D. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as shown on the project drawings (see section 2.5)

E. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be accepted.
F. Bypass air dampers shall be opposed-blade design, and coated with up to 4 mils of Hi-Pro Polyester resin, electrostatically applied and baked. Damper shall include a galvanized manual quadrant actuator.
G. A fan isolation damper, shall **not** be required for single fan systems.
H. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.

2.5 BYPASS AIR PLENUM CURB

A. Exhaust system manufacturer shall supply a structural support curb for the plenum, of specified height, as shown on the drawings.
B. Curb shall be fabricated of a minimum of 14 gauge corrosion resistant coated steel and structurally reinforced.
C. Curbs shall be insulated.
D. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.

2.6 FAN MOTORS AND DRIVE

A. Motors shall be premium efficiency, standard NEMA frame, 1800 RPM, TEFC with a 1.15 service factor. A factory-mounted NEMA 3R disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.
B. Motors shall have cast iron end brackets/bearing housings. Aluminum end brackets will not be accepted.
C. Drive belts and sheaves shall be sized for 200% of the motor horsepower, and shall be readily and easily accessible for service. Drive shall consist of a minimum of two belts under all circumstances.
D. Shaft to be polished and ground steel.
E. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an L-10 life of no less than 100,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
F. All shaft bearings shall have extended lube lines with zerk fittings.

PART 3 INSTALLATION

A. Install fans as indicated, with flexible electrical leads.
B. Pipe housing drain to nearest drain.
C. Install fans in accordance with manufacturer's instructions.

END OF SECTION 23 34 19 00

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SECTION 23 34 23 00 - POWER VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install the following fans indicated by the Contract Documents with supplementary items necessary for proper installation.

1. Centrifugal roof, up-blast, and sidewall exhauster.
2. Centrifugal roof supply fan.
3. Make-up air unit.
4. Centrifugal up-blast grease hood exhaust fan.
5. Tube axial up-blast smoke control exhaust fan.
6. Motors and drives.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
3. AMCA 99 - Standards Handbook.
4. ACMA 203 - Fan Application Manual - Field Performance Measurements.
5. AMCA 204 - Balance Quality and Vibration Levels For Fans
6. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
7. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
8. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
9. NEMA MG1 - Motors and Generators.
10. NFPA 70 - National Electrical Code.

11. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
12. UL 705 – Power Ventilators.

1.04 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal. The sound power levels must not exceed those indicated on Drawings.

C. Fabrication: Conform to AMCA 99.

D. Performance Base: 50 feet above sea level.

E. Fans shall be capable of operating stably at reduced loads imposed by means of variable speed drives, inlet guide vanes or controlling pitch of fan blades.

1.05 SUBMITTALS

A. Product Data:

1. Submittal data for approval for all fans of every description furnished under this section of these Specifications.
2. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, special coatings and construction, electrical characteristics and connection requirements.
3. Fan curves with specified operating point clearly plotted. The recommended range of operation shall be stable.
4. Data on sound power levels for both fan inlet and outlet at rated capacity.
5. All data on fan accessories.

B. Operation and Maintenance Data:

1. Manufacturer's installation instructions and operating and maintenance data.
    a. Submit under provisions of Division 01.
    b. Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under provisions of Division 01 and Division 20.

B. Accept products on Site in factory-fabricated protective containers or coverings, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. Check and maintain equipment on a monthly basis to ensure equipment is being stored in accordance with manufacturer's recommended practices. Additionally, during each check, fans and motors shall be rotated and greased and shafts shall be left approximately 180 degrees from that of previous month. Maintain storage records that indicate these maintenance requirements have been met.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Fans shall be either belt or direct drive as scheduled on Drawings.

C. Select fans such that they do not increase motor size, increase noise level, or increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from specified criteria. Provide fans capable of accommodating static pressure variations of plus or minus 10 percent.

D. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas.

2.02 MANUFACTURERS

A. Greenheck.

B. Or Approved Equal

2.03 CENTRIFUGAL ROOF, UPBLAST, AND SIDEWALL EXHAUSTER

A. Backward inclined fan wheel with spun aluminum housing; resilient mounted motor and drive assembly; 16 gauge aluminum bird screen; square base to suit roof curb with continuous curb gaskets; secured to roof curb with cadmium plated or stainless steel bolts and screws.

B. Roof Curb: Roof curb shall be coordinated with Owner and Contractor.

C. Backdraft Damper: Gravity activated or motorized as indicated. Where type is not indicated on Drawings or Specifications, provide gravity-activated damper. Aluminum construction, felt edged with nylon bearings.

D. Up blast exhausters shall have integral drain trough.

E. Apply three coats of air-dried Heresite coating by fan manufacturer both internal and external to all roof exhausters for corrosive applications.

2.04 CENTRIFUGAL ROOF SUPPLY FAN

A. Forward curved, double width double inlet, with heavy gauge galvanized steel housing; resiliently mounted motor and drive assembly.

B. Backdraft Damper: Gravity activated or motorized as indicated. Where type is not indicated on Drawings or Specifications, provide gravity-activated damper. Aluminum construction, felt edged with nylon bearings.

C. Roof Curb: Roof Curb shall be coordinated with Owner and Contractor.

D. Filters: 1-inch washable, aluminum, permanent type as furnished with unit.

E. Hood shall be easily removable for service.

2.05 MAKE-UP AIR UNIT

A. Unit: Internal frame type construction of G90 galvanized steel with all metal-to-metal surfaces sealed. All components shall be accessible through removable panels. Provide unit on prefabricated roof curb. Installed unit shall be in total compliance with NFPA 96.

B. Where scheduled, electrical, hot water, steam, gas-fired, chilled water, or direct expansion (DX) coils shall be installed in unit. Water and steam coils shall be rated in accordance with ARI 410. Electric coils shall be UL listed with integral heater control cabinet and a separate power connection for the coils. Downstream components of tempered units shall be double wall construction and insulated in accordance with local energy codes.

C. Fan Section: Forward curved, double width double inlet, with heavy gauge galvanized steel housing; resiliently mounted motor and drive assembly.

D. Weather Hood: Construct of G90 galvanized steel with 1-inch washable, aluminum, permanent type as furnished with unit at unit intake. Extended weather hood shall be provided where necessary to ensure minimum ten (10) foot separation between air intake and exhaust air. Weather hood extensions shall be mounted on adjustable legs.

E. Electrical: All electrical components shall be factory wired for a single point power connection. Control center shall include motor starter, control circuit fusing, control transformer (120VAC), integral door interlocking disconnect switch with separate motor fusing and terminal strip with overload protected motor.

F. Backdraft Damper: Gravity activated or motorized as indicated. Where type is not indicated on Drawings or Specifications, provide gravity-activated damper.

2.06 CENTRIFUGAL UPBLAST GREESE HOOD EXHAUST FAN

A. Backward inclined fan wheel, up blast roof fan with spun aluminum housing; resilient mounted motor and drive assembly; square base to suit roof curb with continuous curb gaskets; secured to roof curb with cadmium plated or stainless steel bolts and screws. External fan wiring.

B. Roof Curb: Roof curb shall be coordinated with Owner and Contractor. Vented roof extension, to maintain fan discharge a minimum of 40-inches above roof, shall be provided by fan manufacturer.

C. Integral drain trough, cleanout port, and grease trap.

D. Maximum continuous operating temperature of 400 degrees F.

E. UL 762 Listed and constructed in compliance with NFPA 96.

2.07 TUBE AXIAL UP-BLAST SMOKE CONTROL EXHAUST FAN

A. Propeller shall be fabricated steel. Provide with statically and dynamically balanced steel blades and hubs, securely attached to the fan shafts, ground and polish steel fan shafts, galvanized formed channel steel drive frame assembly, deep formed inlet venture fan panels, heavy gauge galvanized steel windbands with reinforced edges and bolted seams, square base to suit roof curb gaskets; secured with stainless steel bolts and screws.

B. Roof curb: Roof curb shall be coordinated with Owner and Contractor.

C. Butterfly Dampers: Steel or aluminum construction based on the required minimum fan speed required to open damper blades. Provide with magnetic damper latches.

D. Fan shall meet requirements and be listed for AMCA Certified Rating Seal for sound and air performance and UL Listed Power Ventilators for Smoke Control Systems to include the IRI requirements for 500 degrees F for a minimum of 4 hours, SBCCI Standard Fire Prevention Code for requirements of 1000 degrees F for a minimum of 15 minutes.

2.08 AIR CURTAIN UNIT

A. Rigid welded construction for support at each end without need for intermediate support. Air curtain fans shall be provided with a weatherproof housing constructed of minimum 16-gauge rigid welded steel with baked enamel finish by fan manufacturer.

B. Fan wheels shall be forward curved, non-overloading, centrifugal type, double inlet, double width with brazed hubs, statically and dynamically balanced. Wheels and housings shall be galvanized steel.

C. Each curtain shall be furnished with a door switch to energize curtain whenever the door is open and actuate the hot water control valve to maintain the temperature set point. Units shall be provided with factory mounted, factory wired control panels including motor starters, transformer for low voltage door switch and terminal strip for connection to power source. Provide a discharge grille and conduit box for single point connection for fan and controls.

D. Air curtains shall attain air velocities specified within 2 seconds following activation. Air intake and discharge openings shall be protected by bird screens. Air curtain shall be at least as wide as the opening to be protected. Air discharge opening shall be so designed and equipped as to permit outward adjustment of the discharge air. Installation and adjustment shall be in accordance with the manufacturer's written instructions. Interior surfaces of the air curtain shall be accessible for cleaning.

E. Fan noise levels shall not exceed 45 dBA when measured at a distance of ten (10) feet from fan discharge opening.

F. Air curtains designed for use in service entranceways shall develop an air curtain not less than three (3) inches thick at the discharge nozzle. The air velocity shall not be less than 1600 fpm across the entire entryway when measured 3 feet above the floor.

G. Where scheduled, include hot water coils with copper tubes and copper fins. Coil shall be rated at 230 psig and 300 degrees F with capacities per ARI 410. Provide UL approved, factory-mounted and factory-wired electric coils where scheduled.

H. Provide control panel with motor starter, terminal strip, motor overloads, and control transformer. Provide field adjustable time delay relay, ON-OFF-AUTOMATIC switch.

2.09 MOTORS AND DRIVES (ALL UNITS UNLESS OTHERWISE SPECIFIED)

A. Motors: In total compliance with motors and controllers Specification sections.

B. Disconnect Switches: Provide for each fan under Division 26. No switches shall be provided in fan housing. All disconnects shall be external to fan housing.

C. Bearings: L-10 life at 200,000 hours self-aligning, ball or roller bearings.

D. Shafts: Hot rolled steel, ground and polished, with key-way, protectively coated with lubricating oil. Provide 316 stainless steel shafts for corrosive applications.

E. Belt Drive: All belt drives shall be designed for a minimum of 50 percent overload. Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 horsepower and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 horsepower and over. Where more than one belt is required, matched sets shall be used. Include an additional set of drives for each fan to be used for final adjustments. After correct speed has been determined with variable sheave, provide fixed sheaves.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Roof Curbs: Roof curb installation shall be coordinated with Owner and Contractor.

D. Disconnect Switches: Disconnect switches shall be installed adjacent to fan on Unistrut per Division 26. Coordinate installation with Owner.

3.02 PAINTING

A. Provide equipment with factory finish in accordance with the manufacturer's standards. Touch up scratches and marks from handling and installation with masking enamel to match manufacturer's color.

B. Where exhaust fans are required to have Heresite coating, have unit’s factory finished with required number of coats prior to shipping to the Project Site.

C. Refer to Division 09 for Site-applied finishes.

END OF SECTION 23 34 23 00

SECTION 23 36 00 00 - AIR TERMINAL UNITS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 20 01 00 00 – Basic Mechanical Requirements

B. Section 20 05 29 00 – Supports and Sleeves

C. Section 20 05 53 – Piping and Equipment Identification

1.01 SECTION INCLUDES

A. Air Terminal Units:
  a. Single Duct Boxes
  b. Dual Duct Boxes
  c. Series Fan Powered Boxes

B. Variable Volume Regulators

C. Integral Controls

1.02 RELATED SECTIONS

A. Section 23 31 13 13 - Ductwork

B. Section 23 31 13 33 - Ductwork Accessories

C. Section 23 36 13 00a - Air Outlets and Inlets

D. Section 23 01 10 00 – Sequence of Operations

E. Section 23 01 10 00a - Testing, Adjusting and Balancing

F. Section 26 05 19 00 - Cable, Wire and Connectors, 600-Volt

G. Section 26 27 26 00 - Wiring Devices and Floor Boxes

1.03 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems

B. UL 181 - Factory-Made Air Ducts and Connectors

C. ADC 1062 - Air Distribution and Control Device Test Code

1.04 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 00 00.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data under provisions of Section 23 00 00.

D. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation.

E. Include schedules listing discharge and radiated sound power level for each of second through seventh octave bands at inlet static pressures of one inch wg.

F. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years' documented experience.

1.07 WARRANTY

A. Provide one-year manufacturer's warranty under provisions of Section 23 00 00.

PART 2 PRODUCTS

2.01 AIR TERMINAL UNITS:

A. Units shall be primary air distribution assemblies (single duct type, series fan powered type, or dual duct type) complete with casing, insulation, (electric, hot water) heating coil (if scheduled), dampers, actuators, (fan, if fan powered type) controls, transformers, and other appurtenances required for a complete installation. Units shall be of the sizes and capacities scheduled.

B. Casing assembly shall be 22-gauge (minimum) zinc coated galvanized steel. Interior surfaces of casing shall be acoustically and thermally lined with a 1" thick, 4-pound density aluminum foil facing fiberglass insulation with a 4.1 R-value. Casing leakage shall not exceed 2% of the box's maximum scheduled CFM at 3" static pressure. Insulation shall be UL-listed and in compliance with NFPA 90A requirements (i.e. UL-181, UL 723, ASTM: E 84, C 665, C1071).

C. Damper (air valve), with solid steel shaft, shall have a leakage rate of less than 2% of the box's maximum scheduled CFM at two times primary supply air duct static pressure or 6" (whichever is smaller). Dual duct mixing terminals shall contain two air inlet valves (cold duct and hot duct). Unit shall incorporate primary air flow sensing devices to provide input for volume regulation as indicated hereinafter.

E. The air terminal unit shall be provided with a flow cross sensor located in the primary air inlet duct(s) suitable for interfacing with the DDC system flow transducer (if required). Sensor shall provide accuracy within 5% with a 90 degree sheet metal elbow at the inlet of the unit and amplify the sensed airflow signal. Dual duct mixing terminals shall contain two flow sensors, one located in the cold deck inlet, one at the hot deck inlet.

F. The boxes shall be provided with a 24 VAC transformer connected to the unit's incoming power source and properly protected. The transformer shall be of adequate size to provide 24 VAC power for all DDC system components associated with the box.

G. The electric heating coils are factory mounted (if scheduled). Terminal assembly is UL 1995 and ETL certified. Overall length of assembly from inlet panel to discharge is a maximum of 35 inches. The heater frame and cabinet is constructed of heavy gauge galvanized steel. Heating elements are constructed of High Grade wire. Elements are low density and designed to minimize hot spots and nuisance cycling of the thermal protectors. Elements are insulated from the steel frame by floating ceramic bushings. An automatic reset thermal cut-out is provided as primary protection against overheating. Heaters are equipped with a manual reset cut-out for secondary protection. Electric heaters are supplied with air flow switch; disconnect switch, single stage, mercury contactors, terminal blocks, and wiring insulated for 105 °F.

G1. Hot water heating units as scheduled shall include 1, 2, 3 or 4-row coils. Coil capacities shall be as scheduled. A quick opening access panel (optional) shall be provided to allow cleaning and inspection of the coil. The coils shall be constructed of 0.500 in. x 0.016 in. copper tube. Fins shall be 0.0045 in. think aluminum sine wave configuration. The coil shall be contained in a 0.030 in. galvanized steel casing. The coils shall be tested and certified according to AHRI Standard 410. Coil connections can be right hand or left hand as detailed on the drawings. Control valves, automatic air vents and drain vents, if required, shall be supplied and field installed by others.

H. Motors shall be ECM motors with field adjustable fan speed control. Size and voltage as scheduled. Steel Fan blower shall have forward curved blades and be direct coupled to the motor.

I. Dual duct mixing box terminals shall be provided with an access panel located on the bottom side of the terminal, for access to the mixing air section. Panels shall be dual wall insulated with a sheet metal liner, and secured with screws for easy removal and re-attachment. Entire bottom panel of the unit being removable is NOT an acceptable substitution. Controls panels to be mounted to the bottom of the unit.

J. Room temperature sensors associated with these single duct boxes shall be furnished by the Automation Contractor and installed under Section “Direct Digital Control System”.

K. The Automation Contractor shall furnish a DDC Controller and an electronic inlet damper actuator for installation on each VAV box by the VAV box manufacturer. These DDC (Direct Digital Control) devices shall be delivered to the VAV box manufacturer’s factory in sufficient time for the manufacturer to meet its scheduled delivery obligations. The VAV box manufacturer shall factory mount and connect these devices as required for proper operation as required under Division 23, Section 23 01 10 00. The cost of factory-mounting these devices shall be included in the cost of the VAV single inlet boxes.

L. Performance shall be AHRI certified.

M. CONTROL PERFORMANCE: Assemblies shall be able to reset the primary air to any airflow between zero and the maximum CFM shown on Drawings. To allow for maximum flexibility and future changes, it shall be necessary to make only keyboard adjustments to arrange each unit for any maximum air flow within the ranges for each inlet size as scheduled on the Drawings. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection. All terminal units shall be installed with a minimum of four diameters of straight duct directly prior to the entry into each terminal unit connection.

N. GENERAL PERFORMANCE: Devices using mechanical CFM limiters will not be accepted, nor shall it be necessary to change control components to make airflow rate changes. If used, Automation Contractor furnished flow stations shall be furnished, mounted and adjusted by the Automation Contractor with assistance from the Terminal Unit Manufacturer to assure their proper placement. The terminal unit manufacturer shall be responsible only for the construction of the terminal unit and the installation of internal control components installed at the manufacturer’s factory, and shall not be responsible for the installation of controls not installed at the terminal unit manufacturer's factory, and shall not be responsible for the performance of the DDC controls. The performance of DDC controls, especially in connection with terminal units, shall be the responsibility of the DDC Trades and the Automation Contractor.

O. Provide single point electrical connection.

P. CONTROL SEQUENCE: The control sequence arrangements shall be as described below and the terminal units shall be shipped from the manufacturer with all necessary control devices to accomplish each sequence, except as may be provided by the controls manufacturer. The desired sequence shall be adjustable according to space usage or a change in space conditions.

Q. DDC SYSTEMS:

1. Electronic operators and controllers shall be installed by the terminal unit manufacturer. The Direct Digital Control System Trades and the Automation Contractor shall be responsible for the operational performance of the entire system. The terminal unit manufacturer shall be responsible for the performance of the mechanical components of the unit.

2. DDC Controls Description:

    a. These air terminal units shall each be provided with a unit-mounted DDC terminal equipment controller (TEC) provided by the DDC Trades to accept input signals from a room space temperature sensor, the box's velocity sensor and the DDC system controller and a modulating signal to the unit's primary damper, and a signal to the unit's SCR electric heat as required to start/stop the unit and maintain the desired space temperature via the DDC System.

    b. These air terminal units served by primary air handling units shall be energized before the air handling unit is energized. The boxes shall be individually energized by the DDC System when the respective air handling unit is to operate or when a Space Sensor is below its "Low Limit" setpoint.

    c. A DDC Trades furnished electronic space sensor shall modulate, through the unit's TEC, the unit's primary air damper and its respective heating coil valve as required to maintain the desired space temperature.

    d. The air terminal units shall be furnished by the box manufacturer complete with all necessary operating hardware and sensing devices to accept the modulating signals from the Terminal/Equipment Controller (TEC) for the unit's DDC Trades furnished electronic damper operator and DDC Trades furnished electronic controls for the electric heating coil and a contact closure to energize/de-energize the unit controls operations.

    e. Coordinate requirements for all controls components for proper operation of air terminal units with the DDC Trades.

R. MANUFACTURER: All Terminal Units shall be Price Industries SDV 5000, DDS 5000, FDC 5000 with CRAF1 liner. Other units such as manufactured by Titus , Metal*Aire , or Nailor Hart may be considered providing sufficient evidence is provided showing alternate products are of the same or better construction and performance in every respect. Other manufacturers are subject to owner approval and must meet or exceed ALL provisions of the specification WITHOUT exception. Even though specific manufacturers may be named herein, the material supplied by any approved manufacturer shall meet all of the provisions of this specification without exception.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Install in accordance with manufacturer's instructions.

C. Provide clearance for inspection, repair, replacement, and service. The mechanical contractor shall ensure all VAV terminal unit controllers and operators are located a minimum of 30” from all obstructions (walls, pipes, etc.).

D. Provide ceiling access doors or locate units above easily removable ceiling components.

E. Support units individually from structure. Do not support from adjacent ductwork.

F. Connect to ductwork in accordance with Section 23 31 13 13.

END OF SECTION 23 36 00 00

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SECTION 23 36 13 00 - FAN-COIL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Fan coil units.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. NFPA 70 – National Electrical Code.
2. ASHRAE Standard 90.1 – “Energy Standard for Buildings Except Low-Rise Residential Buildings”.
3. ARI 440 – “Room Fan-Coils”.
4. ANSI/UL-883 – “Safety Standards for Fan Coil Units and Room Fan Heater Units”.
5. NFPA 90A – “Standard for the Installation of Air Conditioning and Ventilation Systems”.

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience.

1.05 SUBMITTALS

A. Product Data:

1. Submit product data indicating typical catalog of information including dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics and connection requirements.
2. Submit fan curves with specified operating point clearly plotted. Fan curves shall clearly demonstrate that the fan coil unit will operate stably within the range of performance scheduled.
3. Submit coil performance data as tested and certified per ARI standards.
4. Submit electrical requirements for power supply wiring, clearly indicating factory-installed and field-installed wiring.

5. The submittal shall indicate that all materials meet NFPA 90 flame/smoke spread levels of 25/50 or better.

B. Record Documents:

1. Shop Drawings: Indicate materials and methods of assembly, unit dimensions, weight loading, required clearances, field connection details, electrical characteristics and dimensional views as required to adequately describe the unit.
2. Submit manufacturer's installation instructions.
3. Submit Record Drawings in accordance with Division 01.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and protect products to the Project Site under provisions of Division 01 and Division 20.

B. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.07 WARRANTY

A. Provide one (1) year manufacturer's warranty.

B. Include coverage of fan-coil unit and motors.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Units shall bear an ARI stamp.

C. Fan coil units shall be of the size and configuration as described on the Drawings.

D. Performance as scheduled on the Drawings shall be a minimum requirement. Base coil unit performance on sea level conditions.

E. Fan coil unit height shall be less than or equal to the unit scheduled.

F. Fan coil unit sizes shall be such that the units can be transported to the area of work and installed within the physical space available.

G. This Section does not apply to units that condition raw unconditioned outside air. Refer to Section 23 73 23.

H. [Note: Sound data must be added]

2.02 MANUFACTURERS

A. Envirotec.

B. International Environmental Corp.

C. McQuay.

D. Temtrol

E. Trane.

F. York.

G. Greenheck.

2.03 CASING AND FRAME

A. 18 gauge enclosure, galvanized steel. Frame shall be galvanized steel members.

B. Units exposed below deck shall have a baked enamel finish.

C. Internally insulate units throughout the entire enclosure with 1-inch thick insulation. Insulation shall have a foil facing on the interior.

D. Units shall be completely enclosed with all components including the motor, interior to the casing.

E. Primary Drain Pan:

1. Units shall have a rust-inhibiting IAQ style drain pan across the full width of the unit, extending from the cooling coil to the end of the unit.

2. Insulate drain pan.

3. Drain connection shall be minimum 7/8-inch outside diameter, copper construction.

4. Arrange coil and drain pan connections on the side of the unit as shown on the Drawings.

F. Units shall be provided with integral mounting brackets adequate to support the unit’s weight.

G. Units shall be provided with a discharge and inlet duct collar.

H. Furnish access doors as required to service all elements of the unit from the sides. It shall not be necessary to access the bottom of the unit to service any component.

2.04 FANS AND RELATED COMPONENTS

A. Provide single or dual fans with integral direct drive multiple-speed motor or demountable belt drive motor. Direct drive motor speed shall be set via easily accessible wall-mounted switches.

B. Motors shall be high efficiency type with built-in thermal overload protection.

C. All units scheduled for capacities of 1200 cfm or greater shall be externally isolated with spring isolators.

2.05 COILS

A. Cooling Coils:

1. Copper tube with aluminum fins.

2. Tubes shall be ½-inch outside diameter with a minimum wall thickness of 0.02 inches.

3. For units scheduled with capacities of 600 cfm or less, fins shall be spaced no closer than 14 fins per inch and shall have a minimum fin thickness of 0.0075 inches.

4. Larger capacity units shall have fins spaced no closer than 9 fins per inch and shall have a minimum fin thickness of 0.0088 inches.

B. Where required, heating coils shall be copper tube with aluminum fins. Tubes shall be ½-inch outside diameter with a minimum wall thickness of 0.020 inches. Fins shall be spaced no closer than 14 fins per inch with a minimum fin thickness of 0.0075 inches.

C. Air velocities across cooling coils shall not exceed 500 fpm. Air velocities across heating coils shall not exceed 700 fpm.

D. Coil headers shall be the full size of the coil connection with manual air vents located at the top.

E. Coil frames shall be heavy duty galvanized steel construction.

2.06 FILTERS AND RELATED COMPONENTS

A. All fan coil units shall have provisions for mounting a filter at the unit inlet. Filter shall be a standard ½-inch throwaway filter, 30 percent efficiency.

2.07 UNIT SPECIALTIES

A. For each unit, provide a 22 gauge sheet metal auxiliary drain pan mounted below the entire unit and primary drain pan.

B. Auxiliary drain pans shall either be drained to an approved condensate receiving location or shall be provided with a float switch that shall de-energize the fan coil unit and send an alarm to the building automation system (BAS).

2.08 ELECTRICAL PROVISIONS

A. Each unit shall have a single point of power connection pre-wired at the factory.

B. Starters shall be provided by Division 26.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that areas are ready to receive Work and opening dimensions are as indicated on Shop Drawings.

B. Verify that required utilities are available, in proper location, and ready for use.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Hang units from building structure with pipe hangers anchored to the building, not from piping. Mount units as high as possible to maintain greatest headroom unless otherwise indicated. Refer to Section 20 05 48 for vibration isolation.

D. Protect units with protective covers during balance of construction.

E. Refer to details on the Drawings for piping appurtenances and configuration.

F. Leave adequate room to access and service all components.

G. Arrange fan coil units and ductwork such that poor fan performance does not result.

H. Do not operate units without specified filters being installed.

I. Mount disconnect switches and starters within sight of the fan motor and independent of the unit to allow for maintenance access.

3.03 CLEANING

A. After construction and painting is completed, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filters after Substantial Completion.

END OF SECTION 23 36 13 00

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SECTION 23 36 13 00A - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install diffusers, diffuser boots, registers/grilles, louvers, louver penthouses, roof hoods, and goosenecks indicated by the Contract Documents with supplementary items necessary for proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
2. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
3. ARI 890 – Rating of Air Diffusers and Air Diffuser Assemblies.
4. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
5. SMACNA 1035 - HVAC Duct Construction Standards - Metal and Flexible.

1.04 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with ASHRAE 70.

B. Test and rate performance of louvers in accordance with AMCA 500.

1.05 SUBMITTALS

A. Product Data:

1. Submit product data and Shop Drawings, indicating type, size, location, application, noise level, finish, and type of mounting.
2. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data.

B. Operation and Maintenance Data:

1. Submit manufacturer’s installation instructions under provisions of Division 01.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Grilles, registers and diffusers shall be as scheduled on the Drawings Grilles, registers and diffusers shall be provided with sponge rubber or soft felt gaskets where noted on the Drawings Grilles, slot diffusers and laminar flow bars shall not be internally insulated. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five (5) foot occupancy zone will not exceed 50 fpm nor be less than 25 fpm except where indicated otherwise. Noise levels shall not exceed those published in ASHRAE for the type of space being served (NC level). In the vicinity of lab hoods, terminal velocity at face of hood shall not exceed 20 fpm.

C. Locations of air distribution devices on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be influenced by the established general pattern of the lighting fixtures or architectural reflected ceiling plan, but primarily located to maintain proper air distribution. Where called for on Drawings, grilles, registers and diffusers shall be provided with deflecting devices and manual dampers. These grilles, registers, and diffusers shall be the standard product of the manufacturer, and subject to review by the Architect.

D. Provide a frame compatible with the type of ceiling or wall in which the devices are installed. Refer to Architectural Drawings for exact type of ceiling specified.

E. Coordinate color and finish of the devices with the Architect.

2.02 MANUFACTURERS

A. Grilles, Registers, and Diffusers:

   1. Krueger Manufacturing Company.

   2. Titus Products.

   3. Price Industries.

   4. Nailor Industries.

B. Louvers:

   1. Ruskin.

   2. Greenheck.

C. Roof Hoods:

   1. Greenheck.

   2. Cook.

   3. Acme.

2.03 ROUND CEILING DIFFUSERS

A. Round, adjustable pattern, stamped or spun, multicore type diffuser to discharge air in 360-degree pattern, with sector baffles where indicated.

B. Project diffuser collar above ceiling face and connect to duct with duct ring. In plaster ceilings, provide plaster ring.

C. Fabricate of aluminum, unless otherwise noted, with factory baked enamel, off-white finish.

D. Provide multi-louvered equalizing grid where noted on Drawings.

2.04 RECTANGULAR CEILING DIFFUSERS

A. Rectangular, full louvered face, directional, removable multi-core type diffuser to discharge air in 360-degree pattern. Neck size shall be as scheduled on the Drawings. Provide filler panels, where required, for directional throw diffusers.

B. Fabricate frame and blades of extruded aluminum with factory baked enamel, off-white finish.

C. Provide multi-louvered equalizing grid. where noted on Drawings

D. Provide round neck connection as scheduled on Drawings.

2.05 PERFORATED FACE CEILING DIFFUSERS

A. Perforated face with fully adjustable pattern and removable face.

B. Fabricate of aluminum with factory baked enamel, off-white finish.

C. Provide multi-louvered equalizing grid where noted on Drawings.

D. Provide round neck connection as scheduled on Drawings.

2.06 SQUARE PANEL FACE SUPPLY AND RETURN AIR CEILING DIFFUSER

A. Architectural diffuser with a square panel centered within a square housing similar to the Titus OMNI-AA model. Drawings that depict two-way and three-way throw options are achieved with the use of filler panel (where required) for directional throw diffusers.

B. Opposed blade volume dampers shall be provided with the diffuser, if scheduled on the Drawings. The volume damper design shall be similar to the Titus AG-75.

C. Although the manufacturers show this model being used only as a supply air device, this same diffuser can also be used as a return air device. The neck connection shall be the largest available neck size provided by the manufacturer.

D. Provide round neck connection as scheduled on Drawings.

2.07 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Streamlined blades, depth of which exceeds 3/4-inch spacing, with spring or other device to set blades, vertical face.

B. Fabricate 1-inch margin frame with concealed mounting.

C. Fabricate of steel with minimum 20-gauge frames and minimum 22-gauge blades, steel and aluminum with minimum 20-gauge frame, or aluminum extrusions, with factory baked enamel finish.

D. Opposed blade damper with removable key operator, operable from face shall only be provided with the grille when it is scheduled on the Drawing.

2.08 PERFORATED FACE RETURN/EXHAUST GRILLES

A. Perforated face with back pan, removable face, and neck sizes as indicated on Drawings.

B. Provide frame type as indicated on Drawings.

C. Fabricate completely of 22-gauge steel with a baked enamel off-white finish.

2.09 LIGHT TROFFER DIFFUSERS

A. Single plenum type constructed independent of light troffers with volume and pattern controllers with oval top or side air inlet as scheduled.

B. Match diffusers to light troffers and connect in airtight connection without tools.

C. Fabricate of galvanized steel with welded or soldered joints and finish matte black inside.

2.10 PERFORATED FACE CEILING EXHAUST AND RETURN REGISTERS/GRILLES.

A. 0.0375-inch stainless steel non-aspirating perforated panels with stainless steel plenum for low-velocity applications.

B. Provide quick-opening fasteners with safety chains.

C. Provide multi-louvered equalizing grid where noted on Drawings.

2.11 CEILING EGG CRATE EXHAUST AND RETURN REGISTERS/GRILLES

A. Fixed series of cubes comprised of 1/2 x 1/2 x 1-inch aluminum strips.

B. Fabricate one-inch margin aluminum frame.

C. Fabricate of aluminum with factory baked enamel finish.

D. Provide square uniform height plenum for ducted return and exhaust application of scheduled neck size.

2.12 CEILING LINEAR SLOT DIFFUSERS

A. Continuous linear flow bar slot with adjustable vanes for left, right, or vertical discharge, with volume control. Provide slot width, length and number of slots as scheduled on the Drawings.

B. Fabricate of aluminum extrusions with factory baked enamel finish.

C. Provide support clips and gasket as required for ceiling system.

D. Provide alignment strips for hairline joints and end caps where the slot terminates. Provide mitered corners.

E. Provide black matte finish for all interior exposed-to-view components.

F. Provide externally insulated supply air plenum by diffuser manufacturer.

G. Provide return slot diffuser same as supply, except without the adjustable vane control. Provide return air plenum for ducted return where indicated on Drawings.

2.13 PLENUM SLOT SUPPLY AND RETURN DIFFUSERS

A. Supply or return plenum slot, 3/4-inch, with single extruded aluminum curved deflector blade to create a tight horizontal airflow pattern across the ceiling. Provide slot width, length, and number of slots as scheduled on the Drawings.

B. Diffusers shall discharge air horizontally through two outside sections and vertically through a center down-blow section.

C. Standard nominal lengths shall be 2, 3, 4, or 5 feet. Units shall be constructed of 24-gauge steel. Maximum height of the unit’s plenum shall be 7-inches. Inlets shall have a minimum of 1-1/2-inch depth for duct connection. The standard finish shall be black on the face of the diffuser and pattern deflectors.

D. Diffuser shall be similar to Titus N-1-R diffuser.

2.14 PERIMETER SLOT SUPPLY AND RETURN DIFFUSERS

A. High induction supply and return plenum slot, the supply is a 3/4-inch fixed slot width that produces a horizontal discharge pattern, and a return air slot with a maximum 1-1/2-inch slot width. Provide length as scheduled on the Drawings.

B. Standard nominal lengths shall be 2, 3, 4, or 5 feet. Units shall be constructed of 24-gauge steel. Maximum height of the units shall be 7-inches. Inlets shall have a minimum of 1-1/2-inch depth for duct connection. The standard finish shall be black on the face of the diffuser and pattern deflectors.

C. Diffuser shall be similar to the Titus N-1-R diffuser.

2.15 CEILING LINEAR EXHAUST AND RETURN GRILLES

A. Streamlined blades with 90-degree one-way deflection, 1/8-inch x 3/4-inch on 1/4-inch centers.

B. Fabricate 1-inch margin frame with countersunk screw mounting.

C. Fabricate of steel with 22-gauge minimum frames and 22-gauge minimum blades, steel and aluminum with 20-gauge minimum frame, or aluminum extrusions, with factory baked enamel finish.

D. Opposed blade damper with removable key operator, operable from face shall only be provided with the grille when it is scheduled on the Drawing.

2.16 WALL SUPPLY REGISTERS/GRILLES

A. Streamlined and individually adjustable curved blades to discharge air along face of grille with two-way deflection.

B. Fabricate 1-inch margin frame with countersunk screw, concealed mounting and gasket.

C. Fabricate of aluminum extrusions with factory clear anodized finish.

D. Provide multi-louvered equalizing grid where noted on Drawings.

2.17 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Streamlined blades, depth of which exceeds ¾-inch spacing, with spring or other device to set blades, vertical or horizontal face as scheduled.

B. Fabricate one-inch margin frame with concealed mounting.

C. Fabricate of aluminum with 20-gauge minimum frame, or aluminum extrusions, with factory baked enamel finish.

2.18 LINEAR BAR WALL DIFFUSERS

A. Streamlined blades with 0 to 15 degree deflection, as scheduled, 1/8-inch x 3/4-inch or 1/4-inch centers.

B. Fabricate of aluminum extrusions, with factory clear anodized finish.

C. Fabricate 1/2-inch margin frame with concealed mounting and gasket.

D. Provide concealed fastening, straightening grids and alignment bars.

E. Provide externally insulated plenums by diffuser manufacturer.

F. Provide return bar diffusers same as supply with return air plenum.

G. Silhouette finish.

2.19 LINEAR FLOOR SUPPLY REGISTERS/GRILLES

A. Streamlined blades with zero degree deflection, 7/32-inch x 3/4-inch on 1/2-inch centers.

B. Fabricate of high-grade aluminum extrusions with factory clear anodized finish.

C. Fabricate 3/16-inch margin heavy margin frame with concealed mounting and gasket and mounting frame. Frameless flange for floor installation. Silhouette finish.

D. Provide concealed fastening, straightening grids and alignment bars.

2.20 LABORATORY RADIAL AIR SUPPLY DIFFUSERS

A. High-volume, low velocity performance.

B. Diffuser shall provide non-aspirating radial air pattern and shall be configured with air supply plenums with inlet collars to assure uniform velocity over the diffuser face.

C. Furnish stainless steel back pan and stainless steel faced diffusers for animal holding rooms.

D. Furnish aluminum back pan and aluminum-faced diffusers for laboratories.

E. Performance face drops below ceiling, single-pane back pan and single piece lower chamber. Sectioned diffuser is not acceptable.

2.21 WALL EXHAUST AND RETURN REGISTERS/GRILLES – SEVERE DUTY

A. Streamlined 40-degree fixed blades, at 1/2-inch spacing, with horizontal front blades.

B. Fabricate 1-1/4-inch margin frame with vandal-proof screws.

C. Fabricate totally of steel with minimum 18-gauge frames and minimum 14-gauge blades with factory baked enamel finish.

2.22 LOUVERS

A. Provide 6-inch deep louvers with blades on 45-degree slope with center baffle and return bend, heavy channel frame, bird screen on interior side with 1/2-inch square mesh for exhaust and 3/4-inch for intake.

B. Fabricate of 12-gauge extruded aluminum, welded assembly, with factory prime coat finish.

C. Furnish with exterior angle flange for installation.

D. Fabricate louver penthouses with mitered corners and reinforce with structural angles.

E. Pass 750 feet per minute free velocity with less than 0.10 inches of water pressure drop, based in accordance with AMCA 500. Water penetration less than 0.025 ounce of water per foot of free area at 900 feet per minute. Provide a minimum of 45 percent free area.

2.23 ROOF HOODS

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA 1035, 1-inch classification Duct Construction Standards.

B. Fabricate of galvanized steel, minimum 16-gauge base and 20-gauge hood, or aluminum, minimum 16-gauge base and 18-gauge hood; suitably reinforced; with removable hood; bird screen with 1/2-inch square mesh for exhaust and 3/4-inch for intake, and factory prime coat finish.

C. Roof curb shall be coordinated with Owner and roofing Contractor.

D. Hood outlet area shall be minimum two times the throat area.

2.24 GOOSENECKS

A. Fabricate in accordance with SMACNA 1035, 1-inch classification, of minimum 18-gauge galvanized steel.

B. Roof curb shall be coordinated with Owner and roofing Contractor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, reflected ceiling plans, symmetry, and lighting arrangement.

D. Install air outlets and inlets to ductwork with airtight connection.

E. Provide balancing dampers on duct take-off to diffusers, grilles and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Division 09.

G. Provide all specialties and frames for air distribution devices as required for proper installation in ceiling type as indicated on Architectural Drawings. Provide all cutting and patching of T-bars, gypsum board, and other ceiling systems as required for installation of air devices.

END OF SECTION 23 36 13 00a

SECTION 23 84 13 00 - HUMIDIFIERS

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing and installation of materials for humidifiers. Products shall be as follows or as approved by The University. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
   1. This Section includes the following humidifiers:
      a. Ultrasonic.
      b. Steam injection (if authorized by owner).

C. Definition
   1. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Submittals
   1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
   2. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
      a. Wiring Diagrams: Power, signal, and control wiring.
   3. Field quality-control test reports.
   4. Operation and maintenance data.

E. Quality Assurance
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.2 Products

A. Ultrasonic Humidifiers:
   1. Shall be a packaged self-contained humidifier. Unit shall use multiple ultrasonic transducers to create water droplets of approximately 1 micron in size as a result of water cavitation.
   2. Humidifier shall not user more than 33 watts/pound of humidification.
   3. Unit shall not produce unacceptable noise.
   4. The unit shall not require a flush cycle.
   5. Shall have the following components:
      a. Solenoid valve to control water flow.
      b. Float switches (water level control, low water shut down)
      c. Piezoelectric crystals (transducers)
      d. On/Off Humidistat
   6. Units shall be equal to Humidfirst "Mist-Pac" or "Mist-free" series units.

B. Steam-Injection Humidifiers
   1. Manifold: ASTM A 666, Type 304 stainless steel, steam jacketed, **as directed**; insulated with 1/2-inch (13-mm) fiberglass and stainless-steel jacket; and, **as directed**, extending the full width of duct or plenum with mounting brackets at ends.
   2. Discharge Nozzle and Dispersion Fan:

  - a. Steam-jacketed discharge nozzle, aluminum blade propeller fan with finger guard, and single-speed motor interlocked to operate with humidifier.
  - b. Fan Mounting: Above and behind discharge outlet on bracket integral to discharge outlet.
3. Steam Separator: Cast iron **OR** ASTM A 666, Type 304 stainless steel, **as directed**, with separate, **as directed**, humidifier control valve.
4. Humidifier Control Valve:
   - a. Actuator: Pneumatic **OR** Electric, **as directed**, modulating with spring return.
     OR
     Actuator: As specified in Division 23 Section "Instrumentation And Control For Hvac".
5. Steam Trap: Inverted-bucket type, sized for a minimum of 3 times the maximum rated condensate flow of humidifier at 1/2-psig (3.4-kPa) inlet pressure.
6. Accessories:
   - a. Wall **OR** Return-duct, **as directed**, -mounting humidistat.
   - b. Duct-mounting, high-limit humidistat.
   - c. Aquastat mounted on steam condensate return piping to prevent cold operation of humidifier.
   - d. In-line strainer.
   - e. Airflow switch for preventing humidifier operation without airflow.

1.3 EXECUTION

A. Installation

1. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1, **as directed**.
2. Seal humidifier manifold duct or plenum penetrations with flange.
3. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
4. Install galvanized **OR** stainless, **as directed**, -steel drain pan under each manifold mounted in duct.
   - a. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1, **as directed**.
   - b. Connect to condensate trap and drainage piping.
   - c. Extend drain pan upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.
5. Install manifold supply piping pitched to drain condensate back to humidifier.
6. Install drip leg upstream from steam trap a minimum of 12 inches (300 mm) tall for proper operation of trap.
7. Install steam generator level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results For Hvac".
8. Concrete Bases: Anchor steam generator to concrete base.
   - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   - b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   - d. Install anchor bolts to elevations required for proper attachment to supported equipment.
   - e. Cast-in-place concrete materials and placement requirements are specified in Division 31.
9. Install seismic restraints on humidifiers. Seismic restraints are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
10. Install gas-fired steam generators according to NFPA 54.

B. Connections

1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.

    a. Install piping adjacent to humidifiers to allow service and maintenance.
    b. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
2. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
3. Install piping from safety relief valves to nearest floor drain.
4. Connect gas piping full size to steam-generator, gas-train inlet with union. Gas piping materials and specialties are specified in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**.
5. Connect breeching full size to steam-generator outlet. Venting materials are specified in Division 23 Section "Breechings, Chimneys, And Stacks".
6. Connect combustion-air inlet to intake terminal using PVC piping with solvent-cemented joints. Run from boiler connection to outside and terminate adjacent to flue termination.
7. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
8. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
    a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Remove and replace malfunctioning units and retest as specified above.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

END OF SECTION 23 84 13 00

Specification	Specification Description
25 55 00 00	Building Automation Systems (BAS) General
25 55 00 00a	BAS Commissioning
25 55 00 00b	BAS Basic materiels, interface devices, and sensors
25 55 00 00c	BAS Basic Materials Interface Devices Sensors (retrofit)
25 55 00 00d	BAS Field Panels
25 55 00 00e	BAS Software and Programming
25 55 00 00f	BAS Communication Devices (retrofit)

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SECTION 25 55 00 00 - BUILDING AUTOMATION SYSTEMS (BAS) GENERAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Section Includes:

1. Description of Work.
2. Quality Assurance.
3. System Architecture.
4. Distributed Processing Units/Quantity and Location.
5. Demolition and Reuse of Existing Materials and Equipment.
6. Sequence of Work.

B. Contractor shall furnish and install a direct digital control and building automation system (BAS). The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves (except where noted otherwise) to perform control sequences and functions specified. The BAS for this Project will generally consist of monitoring and control of systems described herein. Reference shall also be made to control Drawings, Sequence of Operation, and points lists.

C. The HVAC systems being controlled are [describe the type of mechanical systems included in the Project]. This Section defines the manner and method by which these controls function.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
2. ASHRAE 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks, latest edition. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. and all current addenda and annexes.
3. Electronics Industries Alliance:
    a. EIA-709.1-A-99: Control Network Protocol Specification.

   b. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification.
   c. EIA-232: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
   d. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes.
   e. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
   f. EIA-472: General and Sectional Specifications for Fiber Optic Cable.
   g. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications.
   h. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications.
   i. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications.

4. Underwriters Laboratories:
   a. UL 916: Energy Management Systems.
   b. UUKL 864: UL Supervised Smoke Control if the BAS is used for smoke control.
5. NEMA Compliance:
   a. NEMA 250: Enclosure for Electrical Equipment.
   b. NEMA ICS 1: General Standards for Industrial Controls.
6. NFPA Compliance:
   a. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
   b. NFPA 70 National Electrical Code (NEC).
7. Institute of Electrical and Electronics Engineers (IEEE)
   a. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems.
   b. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN.
   c. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN.
   d. IEEE 519: Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.

1.04 DEFINITIONS

A. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.

B. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).

C. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications.

D. BACnet/BACnet Standard: BACnet communication requirements as defined by ASHRAE/ANSI 135 and all current addenda and annexes.

E. BACnet Interoperability Building Blocks (BIBB): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a Specification.

F. Binding: In the general sense, binding refers to the associations or mappings of the sources network variable and their intended or required destinations.

G. Building Automation System (BAS): The entire integrated management, monitoring, and control system.

H. Building Controller (BC): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems, acting as a communications router between the LAN backbone and sub-LANs, and data storage for trend information, time schedules, and alarm data.

I. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135).

J. Client: A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.

K. Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).

L. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.

M. Control Systems Server (CSS): This shall be a computer (or computers) that maintains the systems configuration and programming database. This may double as an operator workstation.

N. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic.

O. Functional Profile: A collection of variables required to define key parameters for a standard application. For the HVAC industry, this would include applications like VAV terminal units, fan coil units, etc.

P. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-2001).

Q. Hand Held Device (HHD): Manufacturer’s microprocessor based device for direct connection to a Controller.

R. IT LAN: Reference to the facility’s Information Technology network, used for normal business-related e-mail and Internet communication.

S. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the BAS.

T. Local Area Network (LAN): General term for a network segment within the architecture. Various types and functions of LANs are defined herein.

U. Local Supervisory LAN: Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs and CSSs and the LAN to which the GEMnet will be interfaced. See System Architecture herein.

V. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard (ASHRAE/ANSI 135).

W. UTHSCSA WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.

X. Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.

Y. Operator Interface (OI): A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.

Z. Operator Workstation (OWS): The user's interface with the BAS system. As the BAS network devices are stand-alone, the OWS is not required for communications to occur.

AA. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.

BB. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.

CC. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device (ASHRAE/ANSI 135).

DD. Primary Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture herein.

EE. Router: A device that connects two or more networks at the network layer.

FF. Secondary Controlling LAN: LAN connecting AACs and ASCs, generally lower speed and less reliable than the Primary Controlling LAN. Refer to System Architecture herein.

GG. Server: A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.

HH. SQL: Standardized Query Language, a standardized means for requesting information from a database.

II. Smart Device: A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected. This differs from an ASC in that it typically deals only with one variable.

JJ. XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

1.05 QUALITY ASSURANCE

Use "A" to define any specific qualifications needed; otherwise leave "Reserved".

A. [Reserved].

B. Product Line Demonstrated History: The product line being proposed for the Project must have an installed history of demonstrated satisfactory operation for a length of one (1) year since date of final completion in at least ten (10) installations of comparative size and complexity. Submittals shall document this requirement with references.

C. Installer's Qualifications: Firms specializing and experienced in control system installations for not less than 5 years. Firms with experience in DDC installation projects with point counts equal to this Project and systems of the same character as this Project. If installer is a Value Added Reseller (VAR) of a manufacturer's product, installer must demonstrate at least three years prior experience with that manufacturer's products. Experience starts with awarded Final Completion of previous projects. Submittals must document this experience with references.

D. Installer's Experience with Proposed Product Line: Firms shall have specialized in and be experienced with the installation of the proposed product line for not less than one year from date of final completion on at least three (3) projects of similar size and complexity. Submittals shall document this experience with references.

E. Installer's Field Coordinator and Sequence Programmer Qualifications: Individual(s) shall specialize in and be experienced with control system installation for not less than five (5) years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than two (2) projects of similar size and complexity. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. Proposed individuals must show proof of the following training:

F. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the manufacturer on that product line for installation and configuration.

G. Programming Training: Individuals involved with programming the Site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the manufacturer.

H. Installer's Service Qualifications: The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum five (5) year history of servicing installations of similar size and complexity. Installer must also document at least a one year history of servicing the proposed product line.

I. Installer's Response Time and Proximity:

1. Installer must maintain a fully capable service facility within a 60 mile radius of the Project Site. Service facility shall manage emergency service dispatches and maintain inventory of spare parts.

2. Emergency response times are listed below in this Section. Installer must demonstrate ability to meet response times.

J. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

K. The BAS shall be listed by Underwriters Laboratories (UUKL 864) for Supervised Smoke Control.

1.06 SUBMITTALS

A. General: Submit under provisions of Division 01. Two (2) copies of the materials shall be delivered directly to UTHSCSA Monitoring Services staff, in addition to the copies required by other Sections. In addition, an electronic version of the completed materials shall be provided on CD or DVD. Data can be in native file format or scanned where necessary. Refer to Section 25 08 00 for additional Commissioning submittal requirements.

B. Functional Intent: Throughout the Contract Documents, detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement. Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent. However these will only be allowed with prior approval.

C. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and operation and maintenance (O&M) information shall also be provided in electronic format as follows:

   1. Drawings and Diagrams: Shop Drawings shall be provided on electronic media as an AutoCAD drawing per Owner's CAD standards. All 'x reference' and font files must be provided with AutoCAD files.

   2. Other Submittals: All other submittals shall be provided in Adobe Portable Document Format

D. Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate items.

E. Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.

   1. Shop Drawings: Submit Shop Drawings electronically on AutoCAD software for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Shop Drawings shall contain the following information:

      a. System Architecture and System Layout:

         1) One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.

         2) Provide floor plans locating all control units, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.

      b. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include written description of sequence of operation.

c. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.

d. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). If this information is not available at the time of Shop Drawings submittals, furnish with O&M manual documentation for Owner review and approval. See Section 25 15 00 for additional requirements.

e. Label each control device with setting or adjustable range of control.

f. Label each input and output with the appropriate range.

g. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.

h. With each schematic, provide valve and actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers.

i. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination Drawings on separate Drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that is existing, factory-installed and portions to be field-installed.

j. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.

k. Sheets shall be consecutively numbered.

l. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.

m. Table of Contents listing sheet titles and sheet numbers.

n. User Interface Graphic Screens.

o. Trends.

p. Alarms.

q. Legend and list of abbreviations.

r. Memory allocation projections.

s. Submit along with Shop Drawings but under separate cover calculated and guaranteed system response times of the most heavily loaded LAN in the system.

2. BACnet Protocol Information:

a. Submit the following:

1) BACnet object description, object ID, and device ID, for each I/O point.

2) Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.

3) Submit PICS indicating the BACnet functionality and configuration of each controller.

3. Framed Control Drawings: Laminated control Drawings including system control schematics, Sequence of Operation and panel termination Drawings, shall be provided in panels and mounted in a suitable frame with a .125" Lexan polycarbonate cover for major pieces of equipment, such as air handling units, chillers, boilers, etc. Drawings should be of sufficient size to be easily read. Terminal unit Drawings shall be located in the central plant equipment panel or mechanical room panel.

4. Control Logic Documentation:

   a. Submit control logic program listings (for graphical programming) and logic flow charts illustrating (for line type programs) to document the control software of all control units.

   b. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.

   c. Include written description of each control sequence.

   d. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits.

   e. Sheets shall be consecutively numbered.

   f. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.

   g. Include Table of Contents listing sheet titles and sheet numbers.

   h. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below and in Division 01.

F. Record Documents:

1. Record copies of product data and control Shop Drawings updated to reflect the final installed condition.

2. Record copies of approved control logic programming and database on paper and on CD’s. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of Shop Drawings and including changes to programs made during specified testing.

3. Record copies of approved Project specific graphic software on CDs.

4. Provide as-built network architecture Drawings showing all nodes including a description field with specific controller identification, description and location information.

5. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.

6. Provide record riser diagram showing the location of all controllers.

7. Maintain Project record documents throughout the Warranty Period and submit final documents at the end of the Warranty Period.

G. Operation and Maintenance Data:

1. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.

2. Submit BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.

3. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.

4. Include all submittals (product data, Shop Drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 01.

   a. Contractor shall provide Owner with all product line technical manuals and technical bulletins, to include new and upgraded products, by the same distribution channel as to dealers or branches. This service will be provided for five (5) years as part of the Contract price, and will be offered to Owner thereafter for the same price as to a dealer or branch.

   b. Manufacturer's Certificates: For all listed and/or labeled products, provide certificate of conformance.

   c. Product Warranty Certificates: Submit manufacturers product warranty certificates covering the hardware provided.

1.07 SYSTEM ARCHITECTURE

A. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

B. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.

1. Coordinate all requirements of the BAS WAN / Primary LAN with the UTHSCSA IT Department and EH&S Building Automation Services Department..

2. All BAS utilization of the UTHSCSA IT network specified by Division 25 specifications or by the project construction documents shall be compliant with The University's current IT network standards. Reference the Design Guidelines Element Z IS Network Services & Telecommunication Premises Distribution System Standards. The University's IT department solely manages and governs the UTHSCSA IT infrastructure

3. Division 25 shall not configure, provide nor install any devices or network cables within/inside the UTHSCSA IT network infrastructure. BAS Gateways and BAS Routers provided by Division 25 which utilize the UTHSCSA WAN or Primary LAN shall be approved by UTHSCSA IT prior to connection.

4. The UTHSCSA IT department shall grant approval to utilize The University's IT network and provide Ethernet IP address after all their requirements are satisfied. Upon approval an Ethernet drop will be provided with a jackplate, IP address, and computer name specified by UTHSCSA IT for utilization by the Division 25

C. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-leveled LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.

1. UTHSCSA WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and the Division 25 Contractor shall not configure any components of this WAN. Division 25 may request reconfiguration of the UTHSCSA WAN. Only UTHSCSA IT approved reconfigurations requests shall be executed by UTHSCSA IT. Refer to Section 25 30 00 for requirements.

2. Local Supervisory LAN/Primary Controller LAN ('Primary LAN'): The Local Supervisory/Primary Controller LAN shall be an Ethernet-based, 10/100base-T Ethernet LAN connecting Local Supervisory Controllers, Primary Control LANs, BCs, and OWSs. The LAN serves as the inter-BC gateway and OWS-to-BC gateway and communications path and as the connection point for the UTHSCSA WAN. Contractor shall utilize a dedicated LAN for the control system. The Local Supervisory LAN shall be installed in accordance with the Design Guidelines Element Z IS Network Services & Telecommunication Premises Distribution System Standards by others which are not governed by Division 25.. The BAS network configuration shall be the following:

   a. BACnet/IP as defined in the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet Standard. Point/Object naming conventions are specified in Section 25 15 00.

3. Secondary Controller LAN ('Secondary LAN'): Network used to connect AACs and ASCs. Acceptable communication protocols are BACnet over Ethernet (IEEE802.3), ARCNET (IEEE802.4), Master Slave/ Token Passing or polling as defined in the BACnet standard. Secondary LAN shall not directly connect to the UTHSCSA WAN or UTHSCSA Primary LAN. Division 25 shall provide and install all components of the Secondary LAN as specified in Division 25. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements and other requirements of the Specifications. The BAS Secondary LAN shall not utilize Network Data cable trays without owner approval. BAS Secondary LAN utilizing Network Data cable trays shall comply with the Design Guidelines Element Z IS Network Services & Telecommunication Premises Distribution System Standards.

D. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.

E. Remote Data Access: The system shall support the following methods of remote access to the building data. All remote access shall be approved by UTHSCSA Information Security department prior to installation.

1. Connections shall be secure and shall not allow have the ability to access the UTHSCSA IT network. Connection will allow access to all control system facilities and graphics with appropriate password (minimum 8 characters, preferably alpha-numeric – typical). The University will provide and pay for the digital grade voice line to support this remote connection.

2. Browser-based access: A remote user using a standard browser will be able access all control system facilities and graphics with proper password. Owner will secure and pay for the continuous Internet connection. The following paradigms are acceptable for browser-based access:

   a. Native Internet-based user interfaces (HTML, Java, XML, etc.) that do not require a plug-in.

   b. User interfaces that via a standard browser use a freely distributed and automatically downloaded and installed plug-in or 'thick' client that presents the user interface across the web.

F. The communication speed between the controllers, LAN interface devices, CSS, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with Shop Drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall modify their BAS control design as necessary to accomplish these performance requirements. Generally requirements do not apply when a remote connection must be established via modem:

1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.

2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.

3. 20 seconds between a Level 3-5 alarm occurrence and enunciation at operator workstation.

4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.

5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.

6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.

7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least ten (10) points.

G. Control Systems Server (CSS): This shall be a computer (or computers) that maintain the systems configuration and programming database. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information. Refer to Section 25 11 09 - BAS Operator Interfaces for CSS requirements.

H. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 25 11 09 – BAS Operator Interfaces.

I. The BCs, AACs, ASCs, and SDs shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices as more fully specified in Section 25 55 00 00d - BAS Field Panels.

J. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server or workstation on the Local Supervisory LAN. User tools provided to The University shall allow configuring, updating, maintaining, etc. current configurations and settings whether they are initiated at the server or the end device.

1. Database Schema shall be published and provided to The University to facilitate easy access to the data.

2. Database shall be ODBC compliant or a data access driver shall be provided to act as an ODBC or OLE DB data provider.

K. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other BAS nodes on the network. If a LAN is severed, two (2) separate networks shall be formed and communications within each network shall continue uninterrupted.

L. All line drivers, signal boosters, and signal conditioners etc. shall be provided and approved by UTHSCSA IT as necessary for proper data communication.

M. Anytime any controller’s database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the CSS.

1.08 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

1.09 WARRANTY

A. Contractor shall warrant all products and labor for a period of [Insert Warranty Period] after Substantial Completion.

B. The University reserves the right to make changes to the BAS during the Warranty Period. Such changes do not constitute a waiver of warranty. Contractor shall warrant parts and installation work regardless of any such changes made by Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS. Any disagreement between Owner and Contractor on such matters shall be subject to resolution through the Contract ‘Disputes’ clause.

Engineer shall consult with Owner prior to specifying the response times. Quicker response times may be dictated by the type of systems and facility. Edit to suit the Project.

C. At no cost to The University, during the Warranty Period, Contractor shall provide maintenance services for software, firmware and hardware components as specified below:

1. Maintenance services shall be provided for all devices and hardware specified in the Contract Documents. Service all equipment per the manufacturer’s recommendations.

2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by The University to the Contractor. Emergency service shall be provided 24 hours per day, 7 days per week, and 365 days per year with no exceptions and at no cost to The University.

   a. Response by telephone to any request for service shall be provided within two (2) hours of The University's initial telephone request for service.

   b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to The University's Site within four (4) hours of The University's initial telephone request for such services, as specified.

3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by The University to the Contractor.

   a. Response by telephone to any request for service shall be provided within eight (8) working hours (Contractor specified 40 hours per week normal working period) of The University's initial telephone request for service.

   b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to The University's Site within three (3) working days of The University's initial telephone request for such services, as specified.

4. At any time during the Warranty Period that Contractor is on Site for maintenance, emergency, or normal service, Contractor shall notify Owner via UTHSCSA Monitoring Services and the local building operating personnel. Contractor shall notify said personnel of all work anticipated being involved for the service work. In addition, no work affecting system operation shall commence until express permission is granted. After the work is completed a work order ticket describing in detail all work performed (i.e. hardware replaced or serviced, software or firmware modifications made, etc.), hours worked, follow-up work required, etc., must be signed by an authorized building operators or Monitoring Services personnel.

5. Owner's Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for Owner to call in the event of a need for service. At least one of the lines shall be attended at any given time at all times. Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.

6. Technical Support: Contractor shall provide technical support by telephone throughout the Warranty Period.

7. Preventive maintenance shall be provided throughout the Warranty Period in accordance with the hardware component manufacturer's requirements.

8. In the last month of the Warranty Period, all System software and controller firmware, software, drivers, etc. will be upgraded to the latest release (version) in effect at the end of the Warranty Period.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MATERIALS AND EQUIPMENT

A. Materials shall be new, the best of their respective kinds without imperfections or blemishes, and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where Drawings or Specifications specifically allow existing materials to remain in place.

2.03 UNIFORMITY

A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Refer to additional requirements in other Sections of this Specification.

Digital control stations should specifically be shown on the Drawings. Engineer should select appropriate wall/floor locations that minimize wire and tubing runs, and coordinate these locations with other disciplines. If the Project is a controls renovation only, locate spare breakers in a power panel where the BAS Provider can obtain 120V power and indicate on the Drawings.

3.03 DIGITAL CONTROL STATIONS, CONTROLLER QUANTITY AND LOCATION

Engineer shall designate locations for control stations and specifically reserve wall/floor space and indicate it on the Drawings and coordinate with other disciplines. It is preferable to have the Electrical Contractor provide power (normal, emergency or uninterruptible as applicable). If this is the case, delete the requirement for this Contractor to provide power.

A. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of this Specification.

B. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Restrictions in applying controllers are specified in Section 25 14 00 - BAS Field Panels. Contractor shall extend power to the DCS from an acceptable power panel. If the BAS provider wishes to further distribute panels to other locations, Contractor is responsible for extending power to that location also. Furthermore, Contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the Project and maintain adequate clearance for maintenance access.

C. Contractor shall locate DCS's as referenced. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

Engineer shall consult with Owner prior to specifying the DCS and Controller requirements. Controller requirements shall be dictated by the type of systems and facility. Edit to suit the Project.

D. Contractor shall provide a minimum of the following:

1. One DCS (including at least one controller) in each chilled water/hot water plant mechanical room
2. One DCS (including at least one controller) for each air handler located in applicable mechanical room
3. One DCS (including at least one controller) for each critical fan system
4. One DCS (including at least one controller) for each pumping system
5. One DCS (including at least one controller) for each steam pressure reducing station
6. One controller for each piece of terminal equipment located at the equipment.

3.04 SURGE PROTECTION

A. Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

3.05 CONTROL POWER SOURCE AND SUPPLY

It is preferable to have the Division 26 Contractor supply power to DCS locations and provide the appropriate level of power for all control system components as located by the Engineer. For instance, it is good practice to supply emergency power (and sometimes uninterruptible power when available) at

critical controllers, control system servers, routers, workstations etc. This Section, however, applies mainly to retrofits with no Division 26 Contractor.

A. BAS Provider shall extend all power source wiring required for operation of all equipment and devices provided under Division 25 and the Drawings.

The following item will have to be customized for each system and Project. The consideration is where to provide power for controllers. For distributed controllers that are associated with one unit, it is convenient to power them along with the system so the controller can take action based on the presence of power. However on large centralized panels, it may be best to put these on the most reliable source of power that serves the equipment being controlled and then provide for individual monitoring of the various system power sources by the controller. The object is to make a robust system that does not interpret power failures as device failure and therefore in some instances have to take down the unit for manual acknowledged reset. This can compromise reliability.

B. General requirements for obtaining power include the following:

1. In the case where additional power is required, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120v source fed from a common origin.

2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and is the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls, provide separate transformer

3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served. Furthermore, the controller in that condition shall monitor each power type served to determine so logic can assess whether a failure is due to a power loss and respond appropriately. A three-phase monitor into a digital input shall suffice as power monitoring.

The following item will have to be customized for each system and Project. The consideration is where to provide UPS's for controllers. Engineer shall consult with Owner prior to specifying the UPS requirements. UPS requirements shall be dictated by the type of systems and facility. Edit to suit the Project.

4. Provide an uninterruptible power supply (UPS) system battery backup for each controller or DCS, as shown on the Drawings or specified except terminal equipment controllers. UPS shall protect against blackouts, brownouts, surges and noise.

   a. UPS shall include LAN port and modem line surge protection.

   b. UPS shall be sized for a 7-minute full load runtime, 23-minute 1/2 load runtime, with a typical runtime of up to 60 minutes. Transfer time shall be 2-4 milliseconds.

   c. UPS shall provide a 480-joule suppression rating and current suppression protection for 36,000 amps and provide 90 percent recharge capability in 2-4 hours. Suppression response time shall be instantaneous. UPS low voltage switching shall occur when supply voltage is less than 94 volts.

   d. Provide a Maintenance Bypass Switch that allows input voltage to bypass the UPS and directly power the connected equipment if an abnormal condition prevents the UPS from supporting the load, or if the UPS is required to be taken out of service. Provide all software, cables, peripherals etc. for a complete system.

5. Standalone Functionality: Refer to Section 25 14 00.

The Engineer shall carefully coordinate the training requirements with the needs of Owner’s facilities staff. Expansions of existing systems obviously require less training than new systems. The following generally outlines an on-Site training session. The more advanced training may be better provided off Site on a case-by-case basis. Edit to suit Project.

3.06 BAS START-UP, COMMISSIONING AND TRAINING

A. Refer to Section 25 55 00 00a.

END OF SECTION 25 55 00 00

SECTION 25 55 00 00a - BAS COMMISSIONING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Section includes:

1. BAS and equipment testing and Start-up.
2. Validation of proper and thorough installation of BAS and equipment.
3. Functional testing of control systems.
4. Documentation of tests, procedures, and installations.
5. Coordination of BAS training.
6. Documentation of BAS Operation and Maintenance materials.

B. This Section defines responsibilities of the Contractor to commission the BAS.

C. The term “Owner” shall include a representative from UTHSCSA but is not limited to represent The University exclusively. Coordinate all activities to include all of The University’s representatives.

D. Commissioning is the process of ensuring that all building systems are installed and perform interactively according to the design intent, the systems are efficient and cost effective and meet The University’s operational needs, the installation is adequately documented, and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

E. The Contractor shall direct, coordinate, and oversee the Commissioning process and witness functional performance tests.

F. The University’s TAB Firm may write The University approved control sequence verification sheets for functional performance tests and develop forms using the BAS Provider’s point log to test each point back to the graphical interface. The BAS Provider shall furnish the Contractor with an estimated time to complete this task, which Contractor will incorporate in the Project Schedule. In the event Owner’s TAB Firm is not under contracted for the Project, the Contractor shall write The University approved sequence verification sheets for functional performance tests.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

1.04 CONTRACTOR RESPONSIBILITIES

A. Completely install and thoroughly inspect, startup, test, adjust, balance, and document all systems and equipment.

B. Assist Owner and/or TAB Firm in verification and functional performance testing. This will generally include the following:

1. Attend Commissioning progress and coordination meetings.
2. Prepare and submit required draft forms and systems information.
3. Establish trend logs of system operation as specified herein.
4. Demonstrate system operation.
5. Manipulate systems and equipment to facilitate testing.
6. Provide instrumentation necessary for verification and performance testing.
7. Manipulate control systems to facilitate verification and performance testing.
8. Train Owner as specified in this Section.

C. Compensation for Retesting: Contractor shall compensate Owner for Site time necessitated by incompleteness of systems or equipment at time of functional performance testing. All testing failures, which require on-Site time for retesting, will be considered actual damages to The University. All parties under Contract with The University who are affected by the retesting shall be included in the Contract modification.

1.05 SUBMITTALS

A. The following list outlines the general sequence of events for submittals and commissioning:

1. Submit product data and Shop Drawings and receive approval.
2. Submit BAS logic documentation and receive approval.
3. Submit background graphic screens and receive approval.
4. Submit Start-Up Checklists and manufacturer’s start-up procedures for all equipment provided by the Contractor.
5. Install BAS.
6. Submit BAS Start-Up Test Agenda and Schedule for review.
7. Receive BAS Startup Test Agenda/schedule approval.
8. Submit Training Plan.
9. Simulate sequencing and debug program off-line to the extent practical.
10. Place systems under BAS control where applicable during a scheduled outage.
11. Perform BAS Startup where applicable during a scheduled outage.

12. Prepare and initiate trend log data storage and format trend graphs.
13. Submit completed BAS Start-Up Reports and initial draft of the Operating and Maintenance (O&M) Manuals.
14. Receive BAS Startup Report approval and approval to schedule Demonstrations and Commissioning.
15. Demonstrate systems to Owner.
16. Submit Trend Logs in format specified.
17. Receive demonstration approval and approval to schedule Acceptance Period.
18. Train Owner on BAS operation and maintenance.
19. Substantial Completion.
20. Begin Acceptance Phase.
21. Two-week Operational Test.
22. Perform Functional Performance Testing including point to point verification to graphical interface.
23. Receive Acceptance Period approval, which is Functional Completion for the BAS.
24. Train Owner on final sequences and modes of operation.
25. Install framed control Drawings.
26. Provide Level 1 password access to The University.
27. Revise and re-submit as-built record Drawings and O&M Manuals.
28. Manager of Building Automation Services sign-off required.
29. Final Acceptance.
30. Begin Warranty Phase.
31. Schedule and begin Opposite Season acceptance period.
32. Receive Opposite Season acceptance period approval.
33. Submit as-built record Drawings and O&M Manuals.
34. Update framed control Drawings.
35. Complete Owner Training.
36. End-of-Warranty date/period.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 INSTRUMENTATION

A. Instrumentation required to verify readings and to test the system and equipment performance shall be provided by Contractor and made available to Owner. Generally, no testing equipment will be required beyond that required to perform Contractor's Work under these Contract Documents. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

2.03 TAB AND COMMISSIONING PORTABLE OPERATORS TERMINAL

A. For new Projects, Contractor shall provide portable operators terminal or hand held device to facilitate Testing, Adjusting, and Balancing (TAB) and calibration. This software or device shall support all functions and allow querying and editing of all parameters required for proper calibration and Start-up.

B. Connections shall be provided local to the device being calibrated. For instance, for terminal units, connection of the operator's terminal shall be either at the sensor or at the terminal unit. Otherwise a wireless system shall be provided to facilitate this local functionality.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

3.02 BAS START-UP TESTING, ADJUSTING, CALIBRATION

A. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:

1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.

2. Verify proper electrical voltages and amperages and verify that all circuits are free from faults.

3. Verify integrity/safety of all electrical connections.

4. Coordinate with Owner's TAB Firm to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from Owner's TAB Firm, and note any TAB deficiencies in the BAS Start-Up Report:

    a. Optimum duct static pressure setpoints for VAV air handling units.

    b. Minimum outside air damper settings for air handling units.

    c. Optimum differential pressure setpoints for variable speed pumping systems.

    d. Calibration parameters for flow control devices such as VAV terminal units and flow measuring stations.

        1) Contractor shall provide hand-held device as a minimum to the TAB Firm to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV terminal unit or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.

5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5 percent accurate, test equipment shall be +/-0.25 percent accurate over same range). Record the measured value and displayed value for each device in the BAS Start-up Report.

6. Check and set zero and span adjustments for all transducers and transmitters.

7. For dampers and valves:

    a. Check for adequate installation including free travel throughout range and adequate seal.

    b. Where loops are sequenced, check for proper control without overlap.

8. For actuators:

    a. Check to ensure that device seals tightly when the appropriate signal is applied to the operator.

    b. Check for appropriate fail position, and that the stroke and range is as required.

    c. For pneumatic operators, adjust the operator spring compression as required to achieve close-off. If positioner or volume booster is installed on the operator, calibrate per manufacturer’s procedure to achieve spring range indicated. Check split-range positioners to verify proper operation. Record settings for each device in the BAS Pre-Commissioning Report.

    d. For sequenced electronic actuators, calibrate per manufacturer’s instructions to required ranges.

9. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.

10. For outputs to reset other manufacturer’s devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.

11. Verify proper sequences by using the approved checklists to record results and submit with BAS Start-Up Report. Verify proper sequence and operation of all specified functions.

12. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.

Engineer shall provide the tolerances for the type and criticality of the area or zone being served by the equipment. Engineer may have to specify two or more sets of tolerances for a specific Project. Edit accordingly.

13. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start-up Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):

    a. Duct air temperature: [±1 degrees F].

    b. Space Temperature: [±1 degrees F within 30 minutes].

    c. Chilled Water: [±1 degrees F].

d. Hot water temperature: [±3 degrees F].

e. Duct pressure: [± 0.25 inches wg].

f. Water pressure: [±1 psid].

g. Duct or space Humidity: [±5 percent within 30 minutes].

h. Air flow control: [±5] percent of setpoint velocity.

i. Space Pressurization (on active control systems): [±0.05 inches wg] with no door or window movements.

14. For interface and DDC control panels:

    a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the as-built record Drawings.

    b. Ensure that terminations are safe, secure and labeled in accordance with the as-built record Drawings.

    c. Check power supplies for proper voltage ranges and loading.

    d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.

    e. Check for adequate signal strength on communication networks.

    f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.

    g. Ensure that all outputs and devices fail to their proper positions/states.

    h. Ensure that buffered and/or volatile information is held through power outage.

    i. With all system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.

    j. Check for proper grounding of all DDC panels and devices.

15. For Operator Interfaces:

    a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.

    b. Output all specified BAS reports for review and approval.

    c. Verify that the alarm printing and logging is functional and per requirements.

    d. Verify that trends are archiving to disk and provide a sample to The University for review.

    e. Verify that paging/dial-out alarm annunciation is functional.

    f. Start-up and check out control air compressors, air drying, and filtering systems in accordance with the appropriate section and with manufacturer’s instructions.

    g. Verify proper interface with fire alarm system.

B. Submit Start-Up Test Report: Report shall be completed, submitted, and approved prior to Substantial Completion.

3.03 SENSOR CHECKOUT AND CALIBRATION

A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2 degrees F of each other for temperature and within a tolerance equal to 2 percent of the reading of each other for pressure. Tolerances for critical applications may be tighter.

B. Calibration: Calibrate all sensors using one of the following procedures:

1. Sensors Without Transmitters - Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20 percentage of the expected range.

2. Sensors With Transmitters - Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer’s resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to Section 25 11 10.

3.04 COIL VALVE LEAK CHECK

A. Verify proper close-off of the valves. Ensure the valve seats properly seat by simulating the maximum anticipated pressure difference across the circuit. Demonstrate to The University the verification of zero flow by measuring the coil differential pressure. If there is pressure differential, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.05 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.

B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn’t reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

3.06 BAS DEMONSTRATION

A. All BAS Demonstration shall take place on the main Control Systems Server and MDACC WAN. Schedule to add system to main Control Systems Server and MDACC WAN with Owner at least two (2) weeks in advance to the demonstration. At the time of request, provide all documentation that the following criterions are met:

1. Updated BAS submittals in electronic and hard copy to Owner including the updated riser diagram for the system.

2. Reports on verification of Network Layout Verification including but not limited to Building Controller locations, cable routes with length of cable between controllers and any trunk extenders or trunk isolators.

3. Reports on verification of electrical characteristics of BAS network, communications and electrical integrity of Building Controllers.

4. Reports on verification of traffic on BAS Network including but not limited to COVs between Building Controllers, point commands by the operator, point commands by program across the network, alarm reporting on the network, any unresolved points in the system, integrity of the ports on any Building Controller isolator/extender and results of Building Controller tests running at selected baud rate.

5. Demonstrate to Owner the updates of databases without errors or faults between the temporary Control Systems Server and Building Controllers. If there is no temporary server, demonstrate to Owner after system is added to main Control Systems Server.

6. Reports on verification of system log files, interruption of log files of system traffic and overall acceptable operation of the system where a temporary Control Systems Server is utilized.

B. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of The University. Schedule the demonstration with The University seven (7) calendar days in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to conform to the Contract Documents, so as to require scheduling of additional Site visits by The University for re-demonstration, Contractor shall reimburse Owner for costs of subsequent Site visits.

C. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the Project Site.

D. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by The University.

E. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:

1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.

2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.

3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.

4. Demonstrate correct calibration of input/output devices using the same methods specified for the Start-Up Tests. A maximum of 10 percent of I/O points shall be selected at random by The University for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by Owner for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.

5. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.

6. Demonstrate that all DDC programs accomplish the specified sequence of operation.

7. Demonstrate that the panels and DDC network of panels automatically recover from power failures within five (5) minutes after power is restored.

8. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.

9. Identify access to equipment selected by The University. Demonstrate that access is sufficient to perform required maintenance.

10. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.

F. BAS Demonstration shall be completed and approved prior to Substantial Completion.

G. Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.

3.07 BAS ACCEPTANCE PERIOD

A. After approval of the BAS Demonstration and prior to Contract Close Out Acceptance Phase shall commence. Acceptance Period shall not be scheduled until all HVAC systems are in operation and have been accepted, all required cleaning and lubrication has been performed.

B. Operational Test: At the beginning of the Acceptance Phase, the system shall operate properly for two (2) weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these Specifications. At the end of the two weeks, Contractor shall forward the trend logs to The University for review. Owner shall determine if the system is ready for functional performance testing and document any problems requiring Contractor’s attention.

1. If the systems are not ready for functional performance testing, Contractor shall correct problems and provide notification to The University that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional one-week period.

2. This process shall be repeated until Owner issues notice that the BAS is ready for functional performance testing.

C. During the Acceptance Period, the Contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor’s opinion, the cause of the alarm is not the responsibility of the Contractor, Contractor shall immediately notify The University.

3.08 BAS OPERATOR TRAINING AND O&M MANUALS

A. Provide up to four (4) complete sets of the approved Operations and Maintenance (O&M) Manuals (hard copy and one electronic copy) to be used for training.

B. Contractor shall submit a Training Plan for the scope of training for which BAS Provider is responsible. Training Plan shall be forwarded to the Contractor who will compile, organize, format, and forward to the Engineer for review.

1. Coordinate requirements of Training with the MDACC Monitoring Services Department.

C. On-Site Training: Provide services of BAS Provider's qualified technical personnel for 8-hour days to instruct Owner's personnel in operation and maintenance of BAS. Instruction shall be in classroom setting at the Project Site for appropriate portions of the training. Training may be in non-contiguous days at the request of The University. The University shall notify Contractor seven (7) calendar days in advance of each day of requested training. The Contractor's designated training personnel shall meet with the Engineer and Owner for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall generally be as follows:

1. Basic Operator Workstation (OWS) Training – For all potential users of the OWS:

   a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.

   b. Brief overview of the various parts of the O&M Manuals, including hardware and software programming and operating publications, catalog data, controls installation Drawings, and DDC programming documentation.

   c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.

   d. Demonstration of workstation menu penetration and broad overview of the various workstation features.

   e. Overview of systems installed.

   f. Present all Site-specific point naming conventions and points lists, open protocol information, configuration databases, back-up sequences, upload/download procedures, and other information as necessary to maintain the integrity of the BAS.

   g. Overview of alarm features.

   h. Overview of trend features.

   i. Overview of workstation reports.

2. BAS Hardware Training – For Maintenance and Control Technicians:

   a. Review of installed components and how to install/replace, maintain, commission, and diagnose them.

3. BAS Technician Training:

   a. Introduction to controller programming and overview of the programming application interface.

   b. General review of sequence of operation and control logic for the Project Site, including standalone and fail-safe modes of operation.

   c. Uploading/downloading and backing up programs.

   d. Network administration.

   e. Review of setpoint optimization and fine-tuning concepts.

3.09 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING

A. Trending: Throughout the Warranty Phase, trend logs shall be maintained. Contractor shall forward archive trend logs to The University for review upon Owner request. Owner will review these and notify Contractor of any warranty work required.

B. Opposite Season Testing: Within twelve (12) months of Substantial Completion, Contractor shall schedule and conduct with Owner, Opposite Season functional performance testing. BAS Provider shall participate in this testing and remedy any deficiencies identified.

END OF SECTION 25 55 00 00A

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SECTION 25 55 00 00b - BAS BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them. Building automation system requirements may be specified, but not limited to, the following Sections when applicable:

1. Packaged engine generator system.
2. Fuel oil piping system.
3. Hot water boilers.
4. Computer room air conditioning units.
5. Automatic transfer switch.

1.02 SUMMARY

A. Refer to Section 25 00 00 for general requirements.

B. Wiring.

C. Control Valves and Actuators.

D. Control Dampers and Actuators.

E. Control Panels.

F. Sensors.

G. Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).

H. Transducers.

I. Current Switches.

J. Nameplates.

K. Refer to other Division 20 and Division 23 Sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not Work of this Section.

L. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections.

1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
3. Wiring associated with annunciator and alarm panels (remote alarm panels) and connections to their associated field devices.

4. All other necessary wiring for fully complete and functional control system as specified.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

1.04 WORK BY OTHERS

A. Control Valves furnished under this Section shall be installed under the applicable piping Section under the direction of the BAS Provider who will be fully responsible for the proper operation of the valve.

B. Control Dampers furnished under this Section shall be installed under the applicable air distribution or air handling equipment Section under the direction of the BAS Provider who will be fully responsible for the proper operation of the damper.

C. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the BAS Provider who will be fully responsible for the proper installation and application.

D. Controlled Equipment Power Wiring shall be furnished and installed under Division 26. Where control involves 120 volt (V) control devices controlling 120V equipment, Division 26 Contractor shall extend power wiring to the equipment. BAS Provider shall extend it from the equipment to the control device.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide electronic, pneumatic, and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

2.02 MATERIALS AND EQUIPMENT

A. Instrument Pipe and Tube:

1. Low Pressure Air Instrument Sensing Lines

    a. Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.

    b. Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

B. Secondary LAN Communication Wiring: All wiring shall be in accordance with the latest edition of the National Electrical Code and Division 26. Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved UTHSCSA FM Utilities department. In addition, all wiring jackets shall be labeled “BAS” in three (3) foot or fewer intervals along the length of the jacket material. An example is provided below:

Purpose	Function	Color	Label
Building Level	Communication	Orange	BAS Building Level Communication
Floor level	Communication	Blue	BAS Floor Level Communication
Inputs/Outputs	Panel to device	White	BAS Input Output Device Cable
24VAC	control power	White/Black tracer	BAS 24 VAC Control Power

1. Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC’s, ASC’s and local and remote peripherals outside UTHSCSA IT infrastructure. (e.g., operator workstations, printers, and modems).

2. Local Supervisory LAN: For any portions of this network required under this Section of the Specification, Contractor shall comply with Design Guidelines Element Z IS Network Services & Telecommunication Premises Distribution System Standards. Network shall be run with no splices and separate from any wiring over thirty (30) volts.

3. Secondary Controller LANs: Communication wiring shall be individually 100 percent shielded pairs per manufacturer’s recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by building controller manufacturer.

C. Signal Wiring: Contractor shall run all signal wiring in accordance with the latest edition of the National Electrical Code and Division 26.

1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100 percent shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.

2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

D. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with the latest edition of the National Electrical Code and Division 26.

1. Low voltage control wiring shall be minimum 18-gauge, twisted pair, 100 percent shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

E. Control Panels: Provide control panels with suitable brackets for wall mounting, unless noted otherwise, for each control system. Locate panel adjacent to systems served. Mount center of control panels [60 inches – confirm with Owner] above finished floor or roof.

1. Interior: Fabricate panels of 16-gauge furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock, with manufacturer's standard shop-painted finish and color.

2. Exterior: 16-gauge 304 or 316 stainless steel NEMA 4X enclosure. Panel shall have hinged door, keyed lock, and integral, thermostatically controlled heater. Provide hinged deadfront inside panel when flush-mounted control and/or indicating devices are included in panel. Fiberglass or aluminum, as applicable, to be used when gases that are being used in the panel area are corrosive to stainless steel.

3. Provide UL-listed cabinets for use with line voltage devices.

4. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.

5. All gauges and control components shall be identified by means of nameplates.

6. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.

7. Provide a 6 inch x 6 inch minimum wireway (metal wiring/tubing) trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50 percent wiring and tubing capacity. Wireways shall not be less than 24 inches in length. Control panel wiring shall be installed and distributed in the wireway to minimize routing of wiring and tubing within the control panel. Wireway construction to be the same as the associated control panel.

8. Complete wiring and tubing termination drawings shall be mounted in, and a second set mounted adjacent to, each panel in a frame with Lexan cover of sufficient size to be easily readable.

2.03 STANDARD SERVICE CONTROL VALVES

A. Control valve sizing and selection is the initial responsibility of the Engineer and not left to the BAS Provider. Engineer shall provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature etc. This should be a result of analyzing the valves performance across the range of control. Engineer shall consult with Owner prior to specifying control valves.

B. General:

1. Provide factory fabricated control valves of type, body material and pressure class indicated.

2. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system.

3. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve.

4. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application.

5. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

[The following valves are for use in a standard installation.]

C. Butterfly Type: To be used for two-position control only, unless prior approval is obtained from Owner.

1. Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.

2. Seat: EPDM, except in loop bypass applications where seat shall be metal to metal.

3. Disc: Bronze or stainless steel, pinned or mechanically locked to shaft.

4. Bearings: Bronze or stainless steel.

5. Shaft: 416 stainless steel.

6. Cold Service Pressure: 175 psi.

7. Close Off: Bubble-tight shutoff to 150 psi.
8. Operation: Valve and actuator operation shall be smooth both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to The University.
9. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:
    a. Milwaukee.
    b. Nibco.
    c. Dezurik.

D. Ball Type:

1. Body: Brass or bronze; one-, two-, or three-piece design; threaded ends.
2. Seat: Reinforced Teflon.
3. Ball: Stainless steel.
4. Port: Standard or ‘V’ style.
5. Stem: Stainless steel, blow-out proof design, extended to match thickness of insulation.
6. Cold Service Pressure: 600 psi WOG.
7. Steam working Pressure: 150 psi.
8. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:
    a. Apollo
    b. Nibco.

E. Segmented or Characterized Ball Type:

1. Body: Carbon steel (ASTM 216), one-piece design with wafer style ends.
2. Seat: Reinforced Teflon (PTFE).
3. Ball: Stainless steel ASTM A351.
4. Port: Segmented design with equal-percentage characteristic.
5. Stem: Stainless steel.
6. Cold Service Pressure: 200 psi WOG.
7. Cavitation Trim: Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.
8. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:
    a. Jamesbury R-Series.

b. Fisher.

c. Belimo.

2.04 CRITICAL SERVICE CONTROL VALVES

A. Control valve sizing and selection is the initial responsibility of the Engineer and not left to the BAS Provider. Engineer shall provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature etc. This should be a result of analyzing the valves performance across the range of control. Engineer shall consult with Owner prior to specifying control valves. Refer to the 'Control Valve Specification Sheet' located at the end of this Section. Owner shall complete the required fields designated on the Valve Sheet as noted and required.

B. General:

1. Provide factory fabricated control valves of type, body material and pressure class indicated on the 'Control Valve Specification Sheet' located at the end of this Section. Contractor shall utilize the sheet to submit the control valves for the Project.

2. Valves shall be as manufactured by Fisher Controls International, Valtek Control Products, DeZurik/Copes-Vulcan, Keystone, Leslie Controls Inc., or equal.

3. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system.

4. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve.

5. Control valves shall be equipped with heavy-duty actuators and pilot positioners with proper close-off rating and capability for each individual application.

6. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

2.05 CONTROL DAMPERS

A. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable airflow. Provide parallel or opposed blade dampers as recommended by manufacturer's sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.

B. For general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm (7.62 m/s), differential pressure not greater than 2.5 inches w.c. (622 Pa):

1. Performance: Test in accordance with AMCA 500.

2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.

3. Blades: Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts with set screws, 16 gauge minimum thickness.

4. Blade Seals: Synthetic elastomer, mechanically attached, field replaceable.

5. Jamb Seals: Stainless steel.

6. Shaft Bearings: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.

7. Linkage: Concealed in frame.

8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.

9. Leakage: Less than one percent based on approach velocity of 1500 fpm (7.62 m/s) and 1 inches wg. (249Pa).

10. Maximum Pressure Differential: 2.5 inches wg. (622 Pa).

11. Temperature Limits: -40 to 200 degrees F (-40 to 93 degrees C).

12. Where opening size is larger than 48 inches (1219 mm) wide or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for installation.

C. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6 inches w.c. (1493 Pa):

1. Performance: Test in accordance with AMCA 500.

2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.

3. Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts, 14 gauge minimum extrusion thickness.

4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.

5. Jamb Seals: Stainless steel.

6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.

7. Linkage: Concealed in frame.

8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.

9. Leakage: Less than 0.1 percent based on approach velocity of 4000 fpm. (20.3 m/s) and 1 inches wg. (249Pa).

10. Maximum Pressure Differential: 6 inches wg. (622 Pa).

11. Temperature Limits: -40 to 200 degrees F (-40 to 93 degrees C).

12. Where opening size is larger than 48 inches (1219 mm) wide or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for the installation.

D. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 12 inches w.c.:

1. Performance: Test in accordance with AMCA 500.

2. Frames: Galvanized steel, 12-gauge minimum thickness, welded or riveted with corner reinforcement.

3. Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 3/4 inch (19 mm) shafts with set screws.

4. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.

5. Linkage: 10-gauge minimum thickness galvanized steel clevis type crank arms, 3/16 inch x ¾ inch (4.76 mm x 19 mm) minimum thickness tie rods.

6. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.

7. Leakage: Less than 0.2 percent based on approach velocity of 4000 fpm (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.

8. Maximum Pressure Differential: 12 inches wg. (2984 Pa).

9. Temperature Limits: -40 to 300 degrees F (-40 to 149 degrees C).

10. Where opening size is larger than 48 inches (1219 mm) wide or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for the installation.

E. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm (12.7 m/s), differential pressure not greater than 4 inches w.c. (994 Pa):

1. Performance: Test in accordance with AMCA 500.

2. Frames: Rolled 12-gauge steel strip for sizes 6 inch and smaller, rolled 14-gauge steel channel for larger sizes, galvanized or aluminum finish.

3. Blades: Steel construction, 12-gauge minimum thickness for dampers less than 18 inches (457 mm) in size, 10-gauge minimum thickness for larger dampers.

4. Blade Seals: Full circumference neoprene.

5. Shaft: ½ inch (12.7 mm) diameter zinc or cadmium plated steel.

6. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.

7. Leakage: Less than 0.2 percent based on approach velocity of 4000 fpm (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.

8. Maximum Pressure Differential: 4 inches wg. (994 Pa).

9. Temperature Limits: -40 to 300 degrees F (-40 to 149 degrees C).

F. For general isolation and modulating control service in round ducts up to 60 inches in size at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6 inches w.c. (1492 Pa):

1. Performance: Test in accordance with AMCA 500.

2. Frames: Rolled 10-gauge steel channel for sizes 48 inch and smaller, rolled 3/16 inch (4.76 mm) thick steel channel for larger sizes, galvanized or aluminum finish.

3. Blades: Steel construction, 10-gauge minimum thickness for dampers not greater than 48 inches in size, ¼ inch (6.35 mm) minimum thickness for larger dampers.

4. Blade stops: ½ inch x ¼ inch (12.7 mm x 6.35 mm) full circumference steel bar.

5. Blade Seals: Full circumference neoprene.

6. Shaft: Zinc or cadmium plated steel, angle reinforcing as necessary.

7. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.

8. Leakage: Less than 0.4 percent based on approach velocity of 4000 fpm (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.

9. Maximum Pressure Differential: 6 inches wg. (1492 Pa).

10. Temperature Limits: -40 to 250 degrees F (-40 to 121 degrees C).

2.06 ACTUATORS

A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. Actuators:

1. Ambient Operating Temperature Limits: -10 to 150 degrees F (-12.2 to 66 degrees C).

2. Two Position Electric Actuators: Line voltage (120 volt, 24 volt) with spring return. Provide end switches as required.

3. Electronic Actuators: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, as required. Actuators shall travel full stroke in less than 90 seconds. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. [Parallel actuators on a single valve are not allowed.] or [Where two actuators are required in parallel or in sequence provide an auxiliary actuator driver.] Actuators shall have current limiting motor protection. Actuators shall have manual override where indicated. Modulating actuators for valves shall have minimum rangeability of 40 to 1.

   a. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of steam valve applications shall be design inlet steam pressure plus 50 percent for low pressure steam, and 10 percent for high pressure steam. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.

   b. Subject to compliance with requirements, approved manufacturers are as follows:

      1) Siemens.

      2) Automated Logic.

      3) Belimo.

      4) Johnson Controls.

      5) Delta.

C. Quarter-Turn Actuators (for Ball Valves):

1. Electric:

   a. Motor: Suitable for 120 or 240 volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.

   b. Gear Train: Motor output shall be directed to a self-locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.

   c. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure

   d. Failsafe Positioning: Actuators shall be spring return type for failsafe positioning.

   e. Enclosure: Actuator enclosure shall be a NEMA 4 epoxy coated metal enclosure, and shall have a minimum of two threaded conduit entries.

   f. Limit Switches: Travel limit switches shall be UL approved. Switches shall limit actuator in both open and closed positions.

   g. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.

   h. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.

   i. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.

   j. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.

   k. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.

   l. Ambient Conditions: Actuator shall be designed for operation from –140 to 150 degrees F ambient with 0 to 100 percent relative humidity.

2.07 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, is not designed to work with ‘two-wire’ type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy and repeatability equal to, or better than, the accuracy and repeatability listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

2.08 TEMPERATURE SENSORS (TS)

A. Sensor range: When matched with A/D converter of BC, AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.3 degrees F (0.16 degrees C) (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25 degrees F over five (5) years.

[Engineer shall carefully specify other applications where matched sensors are required for the specific Project.]

B. Matched Sensors: The following applications shall require matched sensors:

1. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5 percent of span plus 0.1 degrees C.

2. Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5 percent of span plus 0.1 degrees C.

[Engineer must designate where various amenities to room sensors are required. The following assumes that this will be indicated on the Contract Documents. Otherwise Engineer must add the clarification below. Edit/Delete the following to suit the systems as applicable.

These are sensors for standard control and monitoring. Consult Owner for direction in the application of sensing element types.]

C. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting, unless noted otherwise. Provide insulated base. Following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.6°F accuracy at calibration point.

2. Provide setpoint adjustment where indicated. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS.

3. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure.

4. Provide current temperature indication via an LCD or LED readout.

[These are sensors for critical control and monitoring. Consult Owner for direction in the application of sensing element types.]

D. Critical Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, +/- 0.1 degrees C/F measured at 0/32 degrees C/F.

2. Provide setpoint adjustment where indicated. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS.

3. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure

4. Provide current temperature indication via an LCD or LED readout, where noted.

[These are sensors for standard control and monitoring. Consult Owner for direction in the application of sensing element types.]

E. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated. Sensor probe shall be 316 stainless steel.

   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3 degrees F accuracy at calibration point

[These are sensors for critical control and monitoring. Consult Owner for direction in the application of sensing element types.]

F. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated. Sensor probe shall be 316 stainless steel.

   1. Sensing element shall be platinum RTD, +/- 0.1 degrees C measured at 0 degrees C.

[Edit the following averaging length per square foot based on how homogeneous the air temperature will be at the installed location. For instance, a preheat sensor of a mixed air plenum will require more length than the discharge off a preheat coil in a 100 percent outside air handling unit.

These are sensors for standard control and monitoring. Consult Owner for direction in the application of sensing element types.]

G. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated.

   1. Sensing element shall be platinum RTD, or thermistor, +/- 0.3 degrees F accuracy at calibration point.

[These are sensors for critical control and monitoring. Consult Owner for direction in the application of sensing element types.]

H. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated.

   1. Sensing element shall be platinum RTD, +/- 0.2 degrees C measured at 0 degrees C.

I. Liquid immersion temperature sensor shall include brass thermowell, sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15 degrees F.

   1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2 degrees C measured at 0 degrees C.

J. Pipe Surface-Mount Temperature Sensor: Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as require for resolution indicated in this Section.

   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4 degrees F accuracy at calibration point.

K. Outside air sensors shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in this Section.

   1. +/- 0.2 degrees C measured at 0 degrees C.

2.09 HUMIDITY TRANSMITTERS

A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

   1. Input Range: 0 to 100% RH.
   2. Accuracy (% RH): +/- 2 percent between 20-90% RH at 77 degrees F, including hysteresis, linearity, and repeatability.
   3. Sensor Operating Range: As required by application.
   4. Long Term Stability: Less than 1 percent drift per year.

B. Acceptable Manufacturers: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series.

2.10 DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. Liquid, Steam and Gas:

   1. General: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc linear output, adjustable span and zero, stainless steel wetted parts.
   2. Ambient Limits: –40 to 175 degrees F (-40 to 121 degrees C), 0 to 100% RH.
   3. Process Limits: –40 to 400 degrees F (-40 to 205 degrees C).
   4. Accuracy: Less than 0.1 percent.
   5. Output Damping: Time constant user selectable from 0 to 36 seconds.
   6. Vibration Effect: Less than +/- 0.1 percent of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
   7. Electrical Enclosure: NEMA 4, 4X, 7, 9.
   8. Approvals: FM, CSA.
   9. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa.

B. General Purpose Low Pressure Air: Generally for each measurement of duct pressure, filter differential pressure or constant volume air velocity pressure measurement where the range is applicable.

   1. General: Loop powered two-wire differential capacitance cell-type transmitter.
   2. Output: Two wire 4-20 mA output with zero adjustment.
   3. Overall Accuracy: Plus or minus 1 percent.
   4. Minimum Range: 0.1 inches w.c.

5. Maximum Range: 10 inches w.c.

6. Housing: Polymer housing suitable for surface mounting.

7. Acceptable Manufacturers: Units shall be Setra, Modus T30, Veris PX Series, or Dwyer Series 616.

8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.

9. Range: Select for specified setpoint to be between 25 percent and 75 percent full-scale.

10. Magnehelic Gauges: Provide Dwyer Series 200 Magnehelic Differential Pressure Gauge (or equal) for each DP transmitter. Provide gauge, mounting bracket, ¼ inch aluminum tubing, static pressure tips, and molded plastic vent valves for each gauge connection. Select range for specified recommended filter loading pressure drop to be 75 percent full-scale. For other DP transmitters select range for specified setpoint to be between 25 percent and 75 percent full-scale.

C. General Purpose Low Pressure/Low Differential Air: Generally for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.

1. General: Loop powered, two-wire differential capacitance cell type transmitter.

2. Output: Two-wire 4-20 mA output with zero adjustment.

3. Overall Accuracy: Plus or minus 1 percent.

4. Minimum Repeatability: +/- .25 percent of reading.

5. Maximum Range: 0.1, 0.25, or 0.5 inches w.c.

6. Housing: Polymer housing suitable for surface mounting.

7. Acceptable Manufacturers: Setra, Modus T30.

8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.

9. Range: Select for specified setpoint to be between 25 percent and 75 percent full-scale.

D. VAV Velocity Pressure: Generally for use in variable volume air velocity pressure measurement where the range is applicable.

1. General: Loop powered two-wire differential capacitance cell type transmitter.

2. Output: Two-wire, 4-20 mA output with zero adjustment.

3. Overall Accuracy: Plus or minus 0.25 percent.

4. Minimum Range: 0 inches w.c.

5. Maximum Range: 1 inch w.c.

6. Housing: Polymer housing suitable for surface mounting.

7. Acceptable Manufacturers: Setra.

8. Range: Select for minimum range that will accept the maximum velocity pressure expected.

9. Magnehelic Gauges: Provide Dwyer Series 200 Magnehelic Differential Pressure Gauge (or equal) for each DP transmitter. Provide gauge, mounting bracket, ¼ inch aluminum tubing, static pressure tips, and molded plastic vent valves for each gauge connection. Select range for specified setpoint to be between 25 percent and 75 percent full-scale.

2.11 AIRFLOW MEASURING STATIONS (AFMS)

A. Fan Inlet Probe: Shall consist of vortex shedding multi-sensor probes which are installed in the inlet of the fan. Individual sensors on the probe provide direct proportional and linear signals to airflow velocity.

1. Sensor Accuracy: +/- 2.0 percent.
2. Interchangeability: +/- 0.5 percent.
3. Velocity Range: 750 to 9000 fpm.
4. Electronics Accuracy: +/- 0.05 percent.
5. Temperature Limits: -20 degrees F to 140 degrees F.
6. Enclosure for Electronics: NEMA 1.
7. Material: Aluminum.
8. Operating Range: Select minimum range to accommodate the expected flow range of the equipment.
9. Acceptable Manufacturers: Tek-Air Systems Inc. ‘Vortek’ Model 7000, or approved equal.

B. Air Flow Traverse Probes:

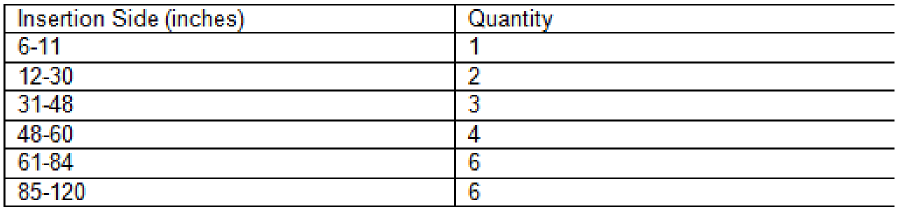
1. Furnish where indicated on the Drawings, vortex shedding multi-sensor insertion type, air flow traverse probes. The probes, and placement of the probes, shall provide measurement accuracy within +/- 2 percent of actual velocity. Probes shall be of cylindrical cross Section and shall indicate no more than a +/- 3 percent deviation from the centerline velocity at a yaw angle of 30 degrees.
2. Probes shall be provided with integral mounting plate, 1/4 compression fitting connections, end mounting rod and be suitable to operate in ambient conditions off 300 degrees F. The probe assemblies shall not have a pressure drop greater than 10 percent of the velocity pressure at the maximum design flow. The probes shall not amplify sound levels in the duct.
3. Submit data indicating the developed differential pressure and pressure loss at the minimum and maximum design flows for each duct location. Provide differential pressure transmitter for measuring velocity, with a range selected to match the velocity of the maximum design flow for the duct served.
    a. Sensor Accuracy: +/- 2.0 percent.
    b. Interchangeability: +/- 0.5 percent.
    c. Velocity Range: 400 to 9000 fpm.
    d. Electronics Accuracy: +/- 0.05 percent.
    e. Temperature Limits: -20 degrees F to 200 degrees F.
    f. Enclosure for Electronics: NEMA 1.

g. Humidity Limits: 0 to 100% RH (non-condensing).

h. Material: 304 stainless steel.

i. Operating Range: Select minimum range to accommodate the expected flow range of the equipment.

j. The following schedule is the minimum probe quantities across either the width or height of the duct sections where the probes are being inserted:



Insertion Side (inches)	Quantity
6-11	1
12-30	2
31-48	3
48-60	4
61-84	6
85-120	6

k. Manufacturer: Tek-Air Model T-FP5000 or approved equal.

2.12 VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

A. Provide a five valve bypass kit for protection of DP sensors where the static on the pipe can cause on over pressure when connected to one port with the other at atmospheric pressure. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, calibration taps, and a bypass valve contained in a NEMA 1 enclosure.

2.13 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. General Service Auto Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or approved equal.

B. General Service Manual Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or approved equal.

C. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range and 0 degrees F to 160 degrees F operating temperature range.

2.14 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150 percent of rated pressure.

B. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls.

2.15 TRANSDUCERS

A. Consult Owner for direction in the application of Transducers.

B. Standard Capacity Electronic-to-Pneumatic (E-P) Transducers: E-P transducers shall be Voltage-to-Pneumatic (V-P) type, Current-to-Pneumatic (I-P) type:

1. Electrical Power Supply: 24 Vac or 24 Vdc.
2. Pneumatic Air Supply: 30 psig (2.07 bar) maximum.
3. Air Capacity: 1100 scim @ 20 psig (300 cm3/sec @ 1.4 bar).
4. Air Consumption: Zero at steady state.
5. Output Span: 0-20 psig (0-1.4 bar).
6. Input: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, or 3-15 Vdc input.
7. Gauges: Provide with main and branch air gauges
8. Enclosure: Polymer designed for surface or panel mount. Provide with main air and branch air gauges.
9. Air Connections: ¼ inch (6.35 mm) barbed.
10. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
11. Acceptable Manufacturers: RE Technologies Model UCP-522.

C. Consult Owner for direction in the application of Transducers.

D. Electronic-to-Pneumatic (E-P) Transducers: E-P transducers shall be Voltage-to-Pneumatic (V-P) type, Current-to-Pneumatic (I-P) type, Phase cut Type:

1. Electrical Power Supply: 24 Vac or 24 Vdc, 100 mA.
2. Accuracy: +/- 1 percent.
3. Feedback: Branch pressure feedback from an on board pressure sensor - VDC Feedback.
4. Override: Manual Potentiometer.
5. Pneumatic Air Supply: 25-30 psig (2.07 bar) maximum.
6. Air Capacity: .5 scim @ 20 psig (300 cm3/sec @ 1.4 bar).
7. Air Consumption: None.
8. Output Span: 3-15 psig factory set field adjustable.
9. Input: 4-20 mA, 0-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-18 Vdc, 0-20V Phase Cut input.
10. Gauges: Provide with main and branch air gauges.
11. Enclosure: NEMA 1. Provide with main air and branch air gauges.
12. Air Connections: ¼ inch (6.35 mm) barbed brass.
13. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
14. Acceptable Manufacturers: TRIATEK CP-3000.

2.16 CURRENT SWITCHES (CS)

A. Clamp-On Design Current Operated Switch (for Constant Speed Motor Status Indication):

1. Range: 2.5 to 135 amps.
2. Trip Point: Adjustable.
3. Switch: Solid state, normally open, 1.0A @ 30VAC/DC.
4. Lower Frequency Limit: 6 Hz.
5. Trip Indication: LED.
6. Approvals: UL, CSA.
7. Max. Cable Size: 350 MCM.
8. Acceptable Manufacturers: Veris Industries H-908.

B. Clamp-on Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938 or RE Technologies RCS 1150.

1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX.

C. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication:

1. Range: 3.5 to 135 Amps.
2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
3. Switch: Solid state, normally open, 0.1A @ 30VAC/DC.
4. Frequency Range: 35 to 75 Hz.
5. Trip Indication: LED.
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM.
8. Acceptable Manufacturers: Veris Industries, Inc. H-904.

D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934.

E. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

2.17 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing):

1. Range: 1-10 amps minimum, 20-200 amps maximum.

2. Trip Point: Adjustable.
3. Output: 0-5 VDC.
4. Accuracy: +/- 0.2 percent from 20 to 100 Hz.
5. Acceptable Manufacturers: KELE SA100.

2.18 OUTDOOR AIR STATIC PRESSURE SENSING TIP

A. Pressure Sensor: Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph. Acceptable manufacturers shall be Dwyer A-306.

B. Low Air Pressure Surge Dampener: 30-second time constant. Acceptable manufacturer shall be Modus SD030.

2.19 CONTINUOUS LEVEL TRANSMITTERS

A. Capacitance Type:

1. General: Provide a loop powered, continuous capacitance type level transmitter with adjustable span and zero.
2. Output: 4-20 mA.
3. Probe: Fluoropolymer coated stainless steel rod or cable. Provide cable probe with end attachment hardware or weight.
4. Electrical Enclosure: NEMA 4, 7.
5. Approvals: UL or CSA.
6. Accuracy: +/- 1 percent of calibrated span.
7. Process Connection: MPT or ANSI Flange as required.
8. Acceptable Manufacturers: Drexelbrook, Endress & Hauser.

B. Hydrostatic Pressure:

1. General: Two wire smart d/p cell type transmitter.
2. Output: 4-20 mA or 1 to 5 volt user selectable linear or square root output.
3. Range: Adjustable span and zero.
4. Probe: Stainless steel wetted parts.
5. Environmental Limits: –40 to 250 degrees F (-40 to 121 degrees C), 0 to 100% RH.
6. Accuracy: Less than 0.1 percent of span.
7. Output Damping: Time constant user selectable from 0 to 36 seconds.
8. Vibration Effect: Less than +/- 0.1 percent of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
9. Electrical Enclosure: NEMA 4, 4X, 7, 9.
10. Approvals: FM, CSA.

11. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, and Johnson-Yokagawa.

[Engineer must clearly indicate which flow meters are acceptable for various duties. Edit to suit the Project.]

2.20 ULTRASONIC FLOW METER FOR WATER SERVICE:

A. General: Single-channel non-wetted ultrasonic meter to measure volumetric fluid using transit-time flow measurement.

B. Measurement: Single channel (Two Channel) measurement.

C. Enclosure: Epoxy-coated aluminum NEMA 4X, IP66 weatherproof.

D. Accuracy: +/- 2 percent of velocity reading at 1 to 40 feet per second.

E. Rangeability: 400 to 1.

F. Repeatability: +/- 0.2 to 0.5 percent at full scale.

G. Input Power: 120 VAC or 24VDC.

H. Operating Temperature: 14 degrees F to 140 degrees F.

I. Control Panel: Stainless Steel case. Digital display: 2-line x 16-character LCD display, LED backlight, configurable to display up to 4 measurement parameters in sequence.

J. Keypad: 6-button internal keypad.

K. Output: Single Channel – one 4-20 mA (Two Channel – two 4-20 mA).

L. Output Units: Velocity in feet per second or meters per second.

M. Volumetric Flow: Cubic feet (ft3), cubic meters (m3), gallons (gal), and liters (L).

N. Totalizer (forward and reverse): Cubic feet (ft3), cubic meters (m3), gallons (gal), and liters (L).

O. Transducer Temperature Range: –40 degrees F to 140 degrees F.

P. Provide all slide track brackets, stainless steel chain or strap, for a complete installation. Provide connecter cables and connectors as required for a complete system.

Q. Acceptable Manufacturers: EMCO.

2.21 ULTRASONIC FLOW METER FOR STEAM SERVICE:

A. General: Single-channel ultrasonic meter to measure the mass flow rate of saturated or superheated steam and the volumetric flow of wet steam.

B. Measurement: Single Channel measurement.

C. Enclosure: Stainless steel NEMA 7/4X.

D. Accuracy: +/- 1 percent of velocity reading at 3 to 150 feet per second.

E. Rangeability: 1500 to 1.

F. Repeatability: +/- 0.2 to 0.5 percent at 1 to 150 feet per second.

G. Input Power: 120 VAC or 24 VAC/VDC.

H. Operating Temperature: -40 degrees F to 140 degrees F.

I. Display: 2-line x 16-character LCD display, LED backlight, configurable to display up to 4 measurement parameters in sequence.

J. Output: 4-20 mA.

K. Transducer:

1. Type: T9.
2. Temperature Range: –40 degrees F to 400 degrees F.
3. Pressure Ratings: 0 to 250 psig operating pressure, 750 psig test pressure
4. Material: Titanium.
5. Connection: Threaded or flanged connection.

L. Acceptable Manufacturers: EMCO Steam Flow Transmitter.

2.22 INSERTION TYPE TURBINE METER FOR WATER SERVICE

A. General:

1. Turbine Insertion Flow Meter sensing method shall be impedance sensing (iron magnetic and non-photoelectric), with volumetric accuracy of +/- 2 percent of reading over middle 80 percent of operating range, and +/- 4 percent of reading over the entire operating range.
2. Turbine Insertion Flow Meter shall have maximum operating pressure of 400 psi and maximum operating temperature of 200 degrees F continuous (220 degrees F peak).
3. All wetted metal parts shall be constructed of 316 stainless steel. Flow meter shall meet or exceed all of the accuracy, head loss, flow limits, pressure and material requirements of the AWWA standard C704-70 for the respective pipe or tube size.
4. Analog outputs shall consist of non-interactive zero and span adjustments, a DC linearly of 0.1 percent of span, voltage output of 0-10 V, and current output of 4-20 mA.

B. Installation: Install in water systems with a minimum of 10 pipe diameters unobstructed flow. Double turbine insertion required at between 10 and 4 diameters unobstructed flow.

C. Acceptable Manufacturers: Onicon Corp. and Hersey.

2.23 VORTEX SHEDDING FLOW METER FOR LIQUID, STEAM AND GAS SERVICE:

A. Output: 4-20 mA, 0-10 Vdc, 0-5 Vdc.

B. Maximum Fluid Temperature: 800 degrees F (427 degrees C).

C. Wetted Parts: Stainless Steel.

D. Housing: NEMA 4X.

E. Turndown: 10:1 minimum.

F. Accuracy: 0.5 percent of calibrated span for liquids, 1 percent of calibrated span for steam and gases.

G. Body: Wafer style or ANSI flanged to match piping Specification.

H. Acceptable Manufacturers: Foxboro 83 series, Johnson-Yokagawa, and Rosemount.

2.24 MAGNETIC FLOW METER FOR WATER SERVICE

A. General Requirements:

1. Sensor shall be a magnetic flow meter, which utilizes Faraday's Law to measure volumetric fluid flow through a pipe.
2. The flow meter shall consist of two (2) elements, the sensor and the electronics. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
3. Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).
    a. Provide a four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube.
    b. Output: 4-20 mA.
    c. Flow Tube: Stainless steel.
    d. Electrical Enclosure: NEMA 4, 7.
    e. Approvals: UL or CSA.
    f. Stability: 0.1 percent of rate over six (6) months.
    g. Process Connection: Carbon steel, ANSI 150 LB, size as required.

B. Meter Accuracy:

1. Under the reference conditions of a 68 degrees F media temperature, a 68 degrees F ambient temperature, a +/- 1 percent nominal power supply voltage, 10 diameters up stream and 5 down of straight piping and a fully developed flow profile; the meter must meet the following requirements:
2. Plus or minus 0.8 percent of reading accuracy in the flow range of 1.65 - 33 ft/sec +/- (0.66/Velocity actual feet per second +0.4) percent of reading accuracy in the flow range of 0 - 1.65 feet per second.
3. Meter repeatability shall be +/- 0.1 percent of rate at velocities > 1.65 feet per second.

C. Calibration: The sensor must be calibrated on an internationally accredited (i.e. NAMAS) flow rig with accuracy better than 0.1 percent. Calibration shall be traceable to National Institute of Standard and Technology.

D. Construction:

1. The meter piping material shall be AISI 304 stainless steel.
2. The meter flange and enclosure material shall be carbon steel.
3. The external surface of the sensor is to be treated with at least .006 inches (150 µm) of Corrosion resistant two-component paint.
4. The inner meter piping shall be protected with a neoprene liner or similar liner.

5. The electrode material shall be AISI 316 Ti or better.

6. The sensor be ANSI class 150 pounds.

E. Electronics:

1. The sensor shall contain a SENSOR-PROM, storing calibration and factory default settings, i.e. the identification of the sensor and size.

2. An ISO 9001 approved company shall manufacture the sensor and electronics.

3. As standard, the electronics must be installable directly on the sensor or installable (remote) up to 1500 feet from the sensor as a maximum.

4. With local electronics installation, the electronics shall be able to withstand three (3) feet water submersion for up to 30 minutes.

5. The electronics shall be compatible with the following power specifications:

   a. 15/230 Vac +10 percent to 15 percent 50-60 Hz.

   b. The power consumption must be 10 Watts or less independent of meter size.

6. The meter electronics shall be able to produce simultaneous scaleable current and frequency/pulse output. The frequency output shall be linearly proportional to flow rate and scaleable from 0-10 kHz. The pulse output shall be scaleable from 50 to 5000 milliseconds duration, suitable for an electromechanical totalizer in engineering units.

7. The electronics must have an internal totalizer for summation of flow.

8. The output of the electronics must be individually, galvanically isolated with an isolation voltage of more than 500 V.

F. Output:

1. The current signal must be either 0-20 mA or 4-20 mA proportional to the flow velocity.

2. The output current signal must accommodate 20 percent over range without loss in linearity.

3. The electronics shall have an alphanumeric LCD display showing actual flow and totalized flow in engineering units.

4. The display and keyboard must be rotatable so that the display can be viewed regardless of sensor orientation.

G. Error Detection:

1. The electronics must be able to detect the flowing error conditions:

   a. Signal connection between electronics and sensor interrupted.

   b. Loss of current to the coil circuit.

   c. Load on the current output.

   d. Defective electronics.

   e. Defective sensor.

   f. Empty pipe.

2. The electronics must have an Error Log where all error conditions occurring within a period of 180 days are stored.

H. Electronic Replacement Programming:

1. The electronics must be immediately replaceable without the need of cable disconnection or renewed configuration programming.
2. When the supply voltage is applied, the electronics must self-configure and display flow without keyboard contact (no programming required).
3. The electronics must be provided with an automatic zero flow setting.
4. The electronics shall be programmable with respect to:
    a. User display options and menu
    b. Setting data
    c. Configuration of outputs
    d. Zero ‘cut-off’ from 0 percent to 9.9 percent of maximum flow.
5. For ease of programming, the electronics shall be programmable away from the meter using the meter Sensor-Prom and a 9 V battery.
6. The electronics shall be suitable for operation in an ambient temperature range of -4 degrees F to 120 degrees F.

I. Acceptable Manufacturers:

1. Engineering Measurements Co. (EMCO MAG 3100 with a model MAG 2500 electronic transmitter and display).
2. Rosemont.
3. Toshiba.
4. Hersey Measurement.
5. Yokogawa Industrial Automation.
6. Endress & Hauser.

2.25 VENTURI FLOW METER FOR WATER SERVICE

A. Flow Sensing Element: Differential-pressure Venturi-type designed for installation in piping.

B. Construction: Bronze or cadmium plated steel with brass quick connect fittings and attached tag with flow conversion data and rated flow. Ends shall be threaded for 2 inches and smaller and flanged or welded for larger than 2 inches.

C. Differential transmitter shall be dual range industrial grade as specified above.

D. Connect differential pressure to venturi and repipe quick connect fittings for measurement. Provide ball valves to isolate quick connects and differential pressure transmitter.

E. Apply Venturi-type flow meters where minimum flow range is no less than 40 percent of maximum flow.

2.26 CO2 SENSORS/TRANSMITTERS (CO2)

A. General: CO2 sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.

B. Accuracy: +/- 36ppm at 800 ppm and 68 degrees F.

C. Stability: 5 percent over 5 years.

D. Output: 4-20 mA, 0-10 Vdc or relay.

E. Mounting: Duct or Wall as indicated.

F. Acceptable Manufacturer: Vaisala, Inc. GMD20 (duct) or GMW20 (wall).

2.27 PNEUMATIC CONTROL COMPONENTS

A. Analog Pressure Gauges: Gauges shall be pneumatic type, minimum 1-1/2 inches (38 mm) in diameter, with white face and black numerals. Surface-mounted gauges shall have chrome plated trim and be a minimum of 2-1/2 inches (64 mm) in diameter.

B. Pneumatic Actuated Pressure Switches (PE) (for 30 psig max pressure control systems): Pressure ranges and sensitivity of PEs shall match control system sequence of operation. Switch operation shall be externally adjustable over the operating pressure range (nominal 0-20 psig, 0 to 138 KPa). PE switches shall be SPDT type, rated for the particular application, and shall be UL listed. PE shall be as manufactured by Penn.

C. Pilot Positioners: Operating span adjustment range is from 3 to 15 psi (21 to 104 kPa), or as required for the actuator being served. Positioner shall be furnished with zero and span adjustments and a mounting bracket for attachment directly to the actuator.

2.28 ELECTRIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley.

B. Electric Solenoid-Operated Pneumatic Valves (EP): EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure. Valves shall be ported 2-way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.

1. Coil Enclosure: Indoors shall be NEMA 1, Outdoors shall be NEMA 3, 4, 7, 9.

2. Fluid Temperature Rating: Valves for compressed air and cold water service shall have 150 degrees F (66 degrees C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.

3. Acceptable Manufacturers: EP valves shall be as manufactured by ASCO or Parker.

4. Coil Rating: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).

C. Low Temperature Detector (‘Freezestat’) (FZ): Low temperature detector shall consist of a ‘cold spot’ element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8 inches x 20 feet (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPDT (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55 degrees F (-9.4 to 12.8 degrees C), factory set at 38 degrees F.

D. High Temperature Detectors (‘Firestat’) (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215 degrees F (-4 to 102 degrees C).

E. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150 degrees F (10 to 65 degrees C), and a minimum 10 degrees F fixed setpoint differential.

F. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed contacts, operating temperature range of 50 to 90 degrees F (10 to 32 degrees C), switch rating of 24 Vac (30 Vac maximum), and both manual and automatic fan operation in both the heat and cool modes.

G. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA 1 enclosure for indoor locations, NEMA 4 for outdoor locations.

1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:

    a. AC coil pull-in voltage range of +10 percent, -15 percent or nominal voltage.

    b. Coil sealed volt-amperes (VA) not greater than four (4) VA.

    c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.

    d. Pilot light indication of power-to-coil and coil retainer clips.

    e. Coil rated for 50 and 60 Hz service.

    f. Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA or approved equal.

2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 horsepower, and 1/3 horsepower, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC or approved equal.

3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.

4. All safety circuits shall be installed to operate individual interposing relays located in the associated equipment control panel. Each safety device (i.e. Freezestat, DP safety, smoke detector, firestat, etc.) wiring circuit shall be installed with individual homeruns back to the associated control panel. See control drawings for details.

H. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA 1 enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse.

I. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall have replaceable fuses in accordance with the NEC. Transformer shall be properly sized for application, and mounted in minimum NEMA 1 enclosure.

1. Transformers shall be manufactured by Westinghouse, Square ‘D’, or Jefferson.

J. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a NEMA 1 enclosure.

1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.

2. TDRs shall be UL and CSA listed, Crouzet type.

K. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley or approved equal.

L. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley or approved equal.

M. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory or approved equal.

N. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley or approved equal.

[Engineer must clearly indicate which refrigerant monitors are acceptable for the application. Only specify the refrigerant monitor in this Section if not provided by the chiller manufacturer in the chiller Specification. Edit to suit the Project.]

2.29 REFRIGERANT MONITOR

A. General: Contractor shall provide a refrigerant sensitive infrared-based stationary refrigerant gas leak monitor system designed to continuously measure refrigerants. Refrigerant monitor shall be coordinated to detect [insert refrigerant types here if known or delete] refrigerants used in chiller equipment installed under Division 23. The alarm system shall comply with the latest edition of ANSI/ASHRAE 15 and local code requirements.

B. The refrigerant monitor shall be capable of monitoring multiple refrigerant gas compounds at multiple locations in concentrations of 0 PPM to a minimum of 1000 PPM. The Monitor shall have a low range resolution of 1 PPM in the range of 1 PPM through 100 PPM. Readings above 100 PPM must be accurate to within +/- 5 percent of reading. Accuracy shall be maintained within ambient environmental ranges of 0 degrees C through 50 degrees C, (32 degrees F through 122 degrees F) and 5 percent through 90 percent relative humidity, non-condensing.

C. The refrigerant monitor shall automatically and continuously monitor the areas through a sample draw type tubular pick up system with an internal pump and filter. The installation of the monitoring control and the tubing shall be in strict accordance with the manufacturer’s instructions. The location, routing, and final position of the sample tubes shall be submitted to the engineer with all necessary shop drawings and monitor specifications and installation instructions. Tubing size, tubing material, and tube length limitations shall be within the specifications of the monitor manufacturer. The location and method of tube support and hangers must be identified on the shop drawings. Each of the sampling tubes shall have end of line filters.

D. The analyzer will be based on infrared detection technology, and will be factory tested and calibrated for the specified refrigerant or refrigerants. Factory certification of the calibrations shall be provided with the O&M manuals. The analyzer shall provide a menu driven or automatic method of checking both zero, span calibration for each sensor, and allow for adjustment.

E. The monitor shall be equipped with four (4) outputs. Three relays shall energize at an adjustable user defined set point based on refrigerant concentration levels. The relay threshold adjustment shall be protected by keyed or password access controls. Adjustments and observations shall be made at the front panel operator interface. The relay threshold values can be viewed without a password. The digital display will continuously display the refrigerant concentration level and alarm status. The fourth output shall indicate a monitor malfunction alarm. The monitor shall also have an analog output that will provide a liner scaled reference to the refrigerant concentration in parts per million. The analog output signal shall be an industry standard DC voltage, or mA current signal.

F. The monitor shall have a NEMA 4 enclosure with a gasketed, hinged front cover. Conduits and tube connections shall be located on the bottom of the enclosure. The enclosure shall have a rust and corrosion resistant finish.

G. The following alarm modes will be provided by the refrigerant monitor:

1. Alarm Level One: Low level of refrigerant concentration at one of the sampling points has detected the presence of a possible refrigerant leak. The initial alarm threshold shall be set to 5 PPM (adjustable) and increased if there are nuisance alarms. This alarm level shall be displayed on the refrigerant monitor interface panel, indicating which sensor has triggered the alarm, and the associated concentration of refrigerant in PPM. This event will also send an Alarm Level One signal to the BAS through a digital output from the monitor relay. This alarm will remain active until the refrigerant concentration is reduced below set point.

2. Alarm Level Two: This alarm shall indicate that one of the sensors has detected a refrigerant concentration that is approaching dangerous levels in the area being monitored. This alarm shall be set to 25 percent below the maximum calculated refrigerant level specified in the latest editions of ANSI/ASHRAE 15 and ASHRAE 34. This alarm will be displayed on the monitor interface, and will indicate which of the sensors has caused the alarm, and the highest concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. This alarm will also be sent to the BAS through the digital output of the relay. In this mode the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared

3. Alarm Level Three: This alarm shall be set at the maximum calculated refrigerant level specified in the latest editions of ANSI/ASHRAE 15 and ASHRAE 34whichever is the lowest concentration. The refrigerant monitor interface will display which sensor has caused the alarm, and the associated concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. If the audible alarm had been silenced by an earlier alarm, the activation of this level three alarm will cause the audible alarm to be activated again. The relay in the refrigerant monitoring panel shall activate the space ventilation system, and will disable all combustion or flame-producing equipment via hardwired control interlocks. In addition, this event and will de-energize the energy source for any hot surface (850 degrees F or 454 degrees C) located in the space. Interlocks must also be provided to close any normally open doors or openings to the space for proper ventilation and isolation during this alarm condition. This alarm level will also signal the BAS through the digital output through the same relay. In this mode, the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared.

H. All alarm conditions shall be report to the BAS system as follows:

1. Alarm Level One: The lowest refrigerant alarm level shall detect the presence of refrigerant in low concentrations and energize a relay to signal a low level alarm to the BAS operator terminal(s). The alarm shall display an alarm message stating that there is a potential refrigerant leak in the designated area.

2. Alarm Level Two: The second refrigerant level alarm shall be a high refrigerant alarm alert. This alarm shall energize a relay to signal the BAS system indicating a high level alarm on the BAS operator terminal(s). This BAS alarm shall state that high levels of refrigerant have been detected in the designated area.

3. Fault Alarm: Reports a high level alarm to the BAS operator terminal(s) that there is a fault in the refrigerant monitoring alarm system.

2.30 NAMEPLATES

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 inch thick, black, with white center core, and shall be minimum 1 inch x 3 inch, with minimum ¼ inch high block lettering. Nameplates for devices smaller than 1 inch x 3 inch shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

2.31 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/- 0.5 percent accurate, test equipment shall be +/- 0.25 percent accurate over same range).

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Owner.

3.02 INSTALLATION OF CONTROL SYSTEMS

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of the latest edition of the National Electrical Code and all local codes.

D. Main Control Air Piping: All main air piping between the compressors and the control panels shall be copper, run per ASTM B88

E. Branch Control Air Piping: Accessible tubing is defined as that tubing run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating and cooling units, instrument panels; across roofs, in pipe chases, etc. Inaccessible tubing is defined as that tubing run in concrete slabs; furred walls; or ceilings with no access.

1. Provide copper tubing with maximum unsupported length of three (3) feet for accessible tubing run exposed to view. Terminal single-line connections less than 18 inches length may be copper tubing, or polyethylene tubing run. Tubing exposed to ambient conditions must be properly protected from sunlight and protected from damage.

2. Provide copper tubing for inaccessible tubing, other than in concrete pour. In a concrete pour polyethylene tubing may be used, install in rigid conduit or vinyl-jacketed polyethylene tubing. Install in galvanized rigid steel conduit at all exterior locations. Install in PVC Schedule 40 conduit if encased in concrete.

3. Polyethylene tubing may be used in control panels provided it is run in a neat and orderly fashion, bundled where applicable, properly supported and installed in a neat and workman like manner. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion.

4. Pressure test control air piping at 30 psi (207 kPa) for 24 hours. Test fails if more than 2 psi loss occurs.

5. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

F. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. Wiring System: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with the latest edition of the National Electrical Code and Division 26. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with the latest edition of the National Electrical Code and Division 26.

3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.

4. All WAN and LAN patch cords shall be approved and installed as approved by owner.

[Engineer shall consult with Owner prior to allowing exposed cable and including the applicable paragraphs.]

5. [Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Install wiring in galvanized rigid steel conduit at all exterior locations and where subjected to moisture. Install in PVC Schedule 40 conduit if encased in concrete. All conduits penetrating partitions, walls or floors shall be sealed with a submitted and approved fire/smoke sealant material to prevent migration of air through the conduit system.

6. [Communication wiring, signal wiring and low voltage control wiring may be run without conduit in concealed, accessible locations if noise immunity is ensured.

   a. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

   b. Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines.

c. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties and not to exceed five (5) foot intervals.

d. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct.

e. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking.]

7. Secondary LAN Communication cabling shall be provided in an Owner approved color dedicated to the BAS.

8. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

G. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

H. Averaging Temperature Sensors: Cover no more than two square feet per linear foot of sensor length except where indicated. Generally, where flow is sufficiently homogeneous/adequately mixed at sensing location, consult Engineer for requirements.

[Engineer must specifically show locations of all flow measuring stations and flow meters and design the straight length of duct of pipe required for accurate sensors. This length must be specifically shown on the drawing and be adequate for the installation.]

I. Airflow Measuring Stations: Install per manufacturer’s recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

[Engineer must specifically show locations of all flow measuring stations and flow meters and design the straight length of duct of pipe required for accurate sensors. This length must be specifically shown on the drawing and be adequate for the installation.]

J. Fluid Flow Sensors: Install per manufacturer’s recommendations in an unobstructed straight length of pipe.

K. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

L. Water Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.

M. Steam Differential Pressure Transmitters: Install as shown on the Drawings per manufacturer’s instructions.

N. Pipe Surface Mount Temperature Sensors: Install with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe Contractor shall neatly cut insulation install sensor, repair or replace insulation and vapor barrier and adequately seal vapor barrier.

O. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

P. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.

Q. Supply Duct Pressure Transmitters:

1. General: Install pressure tips with at least four (4) ‘round equivalent’ duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer’s installation instructions. Locate the transmitter at an accessible location to facilitate calibration.

2. VAV System ‘Down-Duct’ Transmitters: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.

R. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

3.03 REFRIGERANT MONITOR INSTALLATION

A. Install in accordance with the manufacturer’s instructions. Place sensing tips in locations to maximize effectiveness.

B. Hard wire interlocks to the emergency ventilation and shutdown of combustion devices.

END OF SECTION 25 55 00 00b

SECTION 25 55 00 00c - BAS BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS (RETROFIT)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them. Building automation system requirements may be specified, but not limited to, the following Sections when applicable:

1. Packaged engine generator system.
2. Fuel oil piping system.
3. Hot water boilers.
4. Computer room air conditioning units.
5. Automatic transfer switch.

1.02 SUMMARY

A. Section Includes:

1. Wiring.
2. Control Valves and Actuators.
3. Control Dampers and Actuators.
4. Control Panels.
5. Sensors.
6. Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).
7. Transducers.
8. Current Switches.
9. Nameplates.
10. Testing Equipment.

B. Refer to Section 25 00 10 for general requirements.

C. Refer to other Division 20 and Division 23 Sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not Work of this Section.

D. Provide the following electrical Work as Work of this Section, complying with requirements of Division 26 sections:

1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.

3. Wiring associated with annunciator and alarm panels (remote alarm panels) and connections to their associated field devices.

4. All other necessary wiring for fully complete and functional control system as specified.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

1.04 WORK BY OTHERS

A. Control Valves furnished under this Section shall be installed under the applicable piping Section under the direction of the BAS Provider who will be fully responsible for the proper operation of the valve.

B. Control Dampers furnished under this Section shall be installed under the applicable air distribution or air handling equipment Section under the direction of the BAS Provider who will be fully responsible for the proper operation of the damper.

C. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the BAS Provider who will be fully responsible for the proper installation and application.

D. Variable Frequency Drives furnished under section 23 05 13 shall be provided with serial communication protocol information specific to the selected BAS Provider. BAS Provider shall be fully responsible to interface and make available VFD information in the building automation system as monitor only information. Control of the VFD shall meet controller standalone requirements of Section 25.

E. Controlled Equipment Power Wiring shall be furnished and installed under Division 26. Where control involves 120 volt (V) control devices controlling 120V equipment, Division 26 Contractor shall extend power wiring to the equipment. BAS Provider shall extend it from the equipment to the control device.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MATERIALS AND EQUIPMENT

A. General: Provide electronic and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

B. Communication Wiring: All wiring shall be in accordance with the latest edition of the National Electrical Code and Division 26. Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved by MDACC Monitoring Services and MDACC Communications and Computer Services. In addition, all wiring jackets shall be labeled “BAS” in three (3) foot or fewer intervals along the length of the jacket material.

   1. Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC’s, ASC’s and local and remote peripherals outside the MDACC IT infrastructure. (e.g., operator workstations, printers, and modems).

   2. Local Supervisory LAN: For any portions of this network required under this Section of the Specification, Contractor shall comply with Design Guidelines Element Z IS Network Services & Telecommunication Premises Distribution System Standards. Network shall be run with no splices and separate from any wiring over thirty (30) volts.

   3. Secondary Controller LANs: Communication wiring shall be individually 100 percent shielded pairs per manufacturer’s recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by building controller manufacturer.

C. Signal Wiring: Contractor shall run all signal wiring in accordance with the latest edition of the National Electrical Code and Division 26.

   1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100 percent shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.

   2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

D. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with the latest edition of the National Electrical Code and Division 26.

   1. Low voltage control wiring shall be minimum 18-gauge, twisted pair, 100 percent shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

E. Control Panels: Provide control panels with suitable brackets for wall mounting, unless noted otherwise, for each control system. Locate panel adjacent to systems served. Mount center of control panels [60 inches – confirm with Owner] above finished floor or roof.

   1. Interior: Fabricate panels of 16-gauge furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock, with manufacturer's standard shop-painted finish and color.

   2. Exterior: 16-gauge 304 or 316 stainless steel NEMA 4X enclosure. Panel shall have hinged door, keyed lock, and integral, thermostatically controlled heater. Provide hinged deadfront inside panel when flush-mounted control and/or indicating devices are included in panel. Fiberglass or aluminum, as applicable, to be used when gases that are being used in the panel area are corrosive to stainless steel.

   3. Provide UL-listed cabinets for use with line voltage devices.

   4. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.

5. All gauges and control components shall be identified by means of nameplates.

6. Provide a 6 inch x 6 inch minimum wireway (metal wiring/tubing) trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50 percent wiring and tubing capacity. Wireways shall not be less than 24 inches in length. Control panel wiring shall be installed and distributed in the wireway to minimize routing of wiring and tubing within the control panel. Wireway construction to be the same as the associated control panel.

7. Complete wiring and tubing termination Drawings shall be mounted in, and a second set mounted adjacent to, each panel in a frame with Lexan cover of sufficient size to be easily readable.

2.03 CONTROL VALVES

A. General:

1. Provide factory fabricated control valves of type, body material and pressure class indicated on the ‘Control Valve Specification Sheet’ located at the end of this Section. Contractor shall utilize the sheet to submit the control valves for the Project.

2. Valves shall be as manufactured by Siemens, Fisher Controls International, Valtek Control Products, DeZurik/Copes-Vulcan, Keystone, Leslie Controls Inc., or equal.

3. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system.

4. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve.

5. Control valves shall be equipped with heavy-duty actuators and pilot positioners with proper close-off rating and capability for each individual application.

6. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

2.04 CONTROL DAMPERS

A. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable airflow. Provide parallel or opposed blade dampers as recommended by manufacturer’s sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.

B. For general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 feet per minute (fpm) (7.62 m/s), differential pressure not greater than 2.5 inches w.c. (622 Pa):

1. Performance: Test in accordance with AMCA 500.

2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.

3. Blades: Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts with set screws, 16 gauge minimum thickness.

4. Blade Seals: Synthetic elastomer, mechanically attached, field replaceable.
5. Jamb Seals: Stainless steel.
6. Shaft Bearings: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
7. Linkage: Concealed in frame.
8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
9. Leakage: Less than one percent based on approach velocity of 1500 fpm. (7.62 m/s) and 1 inches wg. (249Pa).
10. Maximum Pressure Differential: 2.5 inches wg. (622 Pa).
11. Temperature Limits: -40 to 200 degrees F (-40 to 93 degrees C).
12. Where opening size is larger than 48 inches (1219 mm) wide or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for installation.

C. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6 inches w.c. (1493 Pa):

1. Performance: Test in accordance with AMCA 500.
2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts, 14 gauge minimum extrusion thickness.
4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
5. Jamb Seals: Stainless steel.
6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.
7. Linkage: Concealed in frame.
8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
9. Leakage: Less than 0.1 percent based on approach velocity of 4000 fpm. (20.3 m/s) and 1 inches wg. (249Pa).
10. Maximum Pressure Differential: 6 inches wg. (622 Pa).
11. Temperature Limits: -40 to 200 degrees F (-40 to 93 degrees C).
12. Where opening size is larger than 48 inches (1219 mm) wide or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for the installation.

D. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 12 inches w.c.:

1. Performance: Test in accordance with AMCA 500.
2. Frames: Galvanized steel, 12-gauge minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 3/4 inch (19 mm) shafts with set screws.
4. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
5. Linkage: 10-gauge minimum thickness galvanized steel clevis type crank arms, 3/16 inch x 3/4 inch (4.76 mm x 19 mm) minimum thickness tie rods.
6. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
7. Leakage: Less than 0.2 percent based on approach velocity of 4000 fpm (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
8. Maximum Pressure Differential: 12 inches wg. (2984 Pa).
9. Temperature Limits: -40 to 300 degrees F (-40 to 149 degrees C).
10. Where opening size is larger than 48 inches (1219 mm) wide or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for the installation.

E. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm (12.7 m/s), differential pressure not greater than 4 inches w.c. (994 Pa):

1. Performance: Test in accordance with AMCA 500.
2. Frames: Rolled 12-gauge steel strip for sizes 6 inch and smaller, rolled 14-gauge steel channel for larger sizes, galvanized or aluminum finish.
3. Blades: Steel construction, 12-gauge minimum thickness for dampers less than 18 inches (457 mm) in size, 10-gauge minimum thickness for larger dampers.
4. Blade Seals: Full circumference neoprene.
5. Shaft: ½ inch (12.7 mm) diameter zinc or cadmium plated steel.
6. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
7. Leakage: Less than 0.2 percent based on approach velocity of 4000 fpm. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
8. Maximum Pressure Differential: 4 inches wg. (994 Pa).
9. Temperature Limits: -40 to 300 degrees F (-40 to 149 degrees C).

F. For general isolation and modulating control service in round ducts up to 60 inches in size at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6 inches w.c. (1492 Pa):

1. Performance: Test in accordance with AMCA 500.

2. Frames: Rolled 10-gauge steel channel for sizes 48 inch and smaller, rolled 3/16 inch (4.76 mm) thick steel channel for larger sizes, galvanized or aluminum finish.
3. Blades: Steel construction, 10-gauge minimum thickness for dampers not greater than 48 inches in size, ¼ inch (6.35 mm) minimum thickness for larger dampers.
4. Blade stops: ½ inch x ¼ inch (12.7 mm x 6.35 mm) full circumference steel bar.
5. Blade Seals: Full circumference neoprene.
6. Shaft: Zinc or cadmium plated steel, angle reinforcing as necessary.
7. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
8. Leakage: Less than 0.4 percent based on approach velocity of 4000 fpm (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
9. Maximum Pressure Differential: 6 inches wg. (1492 Pa).
10. Temperature Limits: -40 to 250 degrees F (-40 to 121 degrees C).

2.05 ACTUATORS

A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. Actuators:

1. Ambient Operating Temperature Limits: -10 to 150 degrees F (-12.2 to 66 degrees C).
2. Two Position Electric Actuators: Line voltage (120 volt, 24 volt) with spring return. Provide end switches as required.
3. Modulating Electronic Actuators: Provide actuators with spring return for 0-5 Vdc, 0-10 Vdc, 2-10Vdc, and 4-20 mA on valves greater than 1 inch. 3-point floating actuators for terminal units are to fail in place unless specified otherwise. Actuators shall travel full stroke in less than 150 seconds. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit where indicated. [Parallel actuators on a single valve are allowed only if written approval is given by Owner]. Actuators shall have current limiting motor protection. Actuators shall have manual override on valves 1 inch and larger. Modulating actuators for valves shall have minimum rangeability of 40 to 1.
    a. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of steam valve applications shall be design inlet steam pressure plus 50 percent for low pressure steam, and 10 percent for high pressure steam. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.
    b. Subject to compliance with requirements, approved manufacturers are as follows:
        1) Siemens.
        2) Automated Logic.

3) Belimo.

4) Johnson Controls.

5) Delta.

6) Substitutions: By written approval from Owner.

2.06 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, is not designed to work with ‘two-wire’ type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy and repeatability equal to, or better than, the accuracy and repeatability listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, nonrepeatability and hysteresis.

2.07 VFD SERIAL COMMUNICATION

A. VFD Serial communications shall include, but not be limited to monitor the following feedback signals:

1. Process variable.
2. Output speed/frequency.
3. Current
4. Torque
5. Power (kW)
6. Operating hours
7. Kilowatt hours (kWh)
8. Relay outputs
9. Diagnostic warning and fault information

2.08 TEMPERATURE SENSORS (TS)

A. Sensor range: When matched with A/D converter of BC, AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.8 degrees F (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25 degrees F over five (5) years.

B. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting, unless noted otherwise. Provide insulated base. Sensor color and type shall match surrounding existing sensor when applicable. Following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, ±0.6 degrees F accuracy at calibration point.

2. Provide setpoint adjustment where indicated. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS.

3. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure.

4. Provide current temperature indication via an LCD or LED readout, where indicated.

C. Single-Point Duct Temperature Sensor: Application allowed on supply air volumes of 2000 CFM or less and non-critical return air readings. Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated.

1. Sensing element shall be 100 Ohm platinum RTD which transmits a 4 to 20 mA output signal. The accuracy of this sensor shall be ± 0.7 degrees F. This type of sensor does not require field calibration and shall be replaced if tolerance of ± 1.4 degrees F is exceeded.

D. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated.

1. Sensing element shall be 100 Ohm platinum RTD which transmits a 4 to 20 mA output signal. The accuracy of this sensor shall be ± 0.7 degrees F. This type of sensor does not require field calibration and shall be replaced if tolerance of ± 1.4 degrees F is exceeded.

E. Liquid immersion temperature sensor shall include brass thermowell, sensor and connection head for wiring connections. Temperature range shall be as required to fit the application

1. (Scale 20 – 70 degrees F) Sensing element shall be 100 Ohm platinum RTD which transmits a 4 to 20 mA output signal. The accuracy of this sensor shall be ± 0.6 degrees F. This type of sensor does not require field calibration and shall be replaced if tolerance of ± 1.2 degrees F is exceeded.

2. (Scale 30 – 250 degrees F) Sensing element shall be 100 Ohm platinum RTD which transmits a 4 to 20 mA output signal. The accuracy of this sensor shall be ± 0.7 degrees F. This type of sensor does not require field calibration and shall be replaced if tolerance of ± 1.4 degrees F is exceeded.

F. Pipe Surface-Mount Temperature Sensor: Shall be used only where indicated or by written approval by Owner. Sensor shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point.

1. Sensing element shall be 100 Ohm platinum RTD which transmits a 4 to 20 mA output signal. The accuracy of this sensor shall be ± 1.1 degrees F on a range of 30 - 250 degrees F scale. This type of sensor does not require field calibration and shall be replaced if tolerance of ± 1.5 degrees F is exceeded.

G. Outside air sensors shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage.

1. Sensing element shall be 100 Ohm platinum RTD which transmits a 4 to 20 mA output signal. The accuracy of this sensor shall be ± 0.6 degrees F. This type of sensor does not require field calibration and shall be replaced if tolerance of ± 1.2 degrees F is exceeded.

2.09 HUMIDITY TRANSMITTERS

A. Units shall be suitable for their application. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

1. Input Range: 0 to 100% RH.
2. Accuracy (% RH): ±2 percent between 20-90% RH at 77 degrees F, including hysteresis, linearity, and repeatability.
3. Sensor Operating Range: As required by application.
4. Long Term Stability: Less than 1 percent drift per year.

B. Acceptable Manufacturers: Units shall be Siemens, Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series.

2.10 DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. Liquid, Steam and Gas:

1. General: Two-wire smart DP cell type transmitter, 4-20 mA linear output, adjustable span and zero, stainless steel wetted parts.
2. Ambient Limits: 0 to 175 degrees F.
3. Process Limits: 0 to 175 degrees F.
4. Accuracy: Less than 0.3 percent.
5. Output Damping: Time constant user selectable from 0 to 36 seconds.
6. Vibration Effect: Less than ±0.1 percent of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
7. Electrical Enclosure: NEMA 4, 4X, 7, 9.
8. Approvals: FM, CSA.
9. Acceptable Manufacturers: Setra, Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa.

B. General Purpose Low Pressure Air: Generally for each measurement of duct pressure, filter differential pressure or constant volume air velocity pressure measurement where the range is applicable. Sensor shall be in range at all times.

1. General: Loop powered two-wire differential capacitance cell-type transmitter.
2. Output: Two wire 4-20 mA output with zero adjustment.
3. Overall Accuracy: Plus or minus 1 percent.
4. Minimum Range: 0.1 inches w.c.
5. Maximum Range: 10 inches w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Units shall be Setra,
8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
9. Magnehelic Gauges: Provide Dwyer Series 200 Magnehelic Differential Pressure Gauge (or equal) for each DP transmitter for filter differential pressure. Provide gauge, mounting bracket, ¼ inch aluminum tubing, static pressure tips, and molded plastic vent valves for each gauge connection. Select range for specified recommended filter loading pressure drop to be 75 percent full-scale. For other DP transmitters select range for specified setpoint to be between 25 percent and 75 percent full-scale.

2.11 VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

A. Provide a five valve bypass kit for protection of DP sensors where the static on the pipe can cause on over pressure when connected to one port with the other at atmospheric pressure. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, calibration taps, and a bypass valve contained in a NEMA 1 enclosure.

2.12 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. General Service Auto Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or approved equal.

B. General Service Manual Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or approved equal.

C. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range and 0 degrees F to 160 degrees F operating temperature range.

2.13 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150 percent of rated pressure.

B. Acceptable Manufacturers: Siemens, Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls.

2.14 CURRENT SWITCHES (CS)

A. Clamp-On Design Current Operated Switch (for Motor Status Indication):

1. Range: 3.5 to 135 amps.
2. Trip Point: Adjustable.
3. Switch: Solid state, normally open, 0.1A @ 30VAC/DC.
4. Trip Indication: LED.
5. Approvals: UL, CSA.
6. Maximum Cable Size: 350 MCM.
7. Manufacturers: Veris Industries H-608, H-904, H-908.
    a. Veris Model Number H-608 restricted to constant speed motors rated 40 horsepower or less.
    b. Veris Model Number H-904 required on VFD motors.

B. Variable Speed Status: Contractor shall utilize programmable status contacts from the VSD where applicable.

2.15 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing)

1. Range: 1-10 amps minimum, 20-200 amps maximum.
2. Trip Point: Adjustable.
3. Output: 0-5 VDC.
4. Accuracy: ±0.2 percent from 20 to 100 Hz.
5. Acceptable Manufacturers: KELE SA100.

[Engineer must refer to the BAS Master Specification Section 25 11 10 for the following applications if needed:
Airflow Measuring Stations (AFMS)
Ultrasonic Flow Meter for Water Service
Ultrasonic Flow Meter for Steam Service
Insertion Type Turbine Meter for Water Service
Vortex Shedding Flow Meter for Liquid, Steam and Gas Service
Magnetic Flow Meter for Water Service
Venturi Flow Meter for Water Service
Refrigerant Monitor]

2.16 CO_2 SENSORS/TRANSMITTERS (CO2)

A. General: CO_2 sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.

B. Accuracy: ±100 ppm.

C. Stability: 5 percent over 5 years.

D. Output: 4-20 mA, 0-10 Vdc or relay.

E. Mounting: Duct or Wall as indicated.

F. Acceptable Manufacturer: Vaisala, Inc. GMD20 (duct) or GMW20 (wall).

2.17 ELECTRIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley.

B. Low Temperature Detector (‘Freezestat’) (FZ): Low temperature detector shall consist of a ‘cold spot’ element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8 inch x 20 feet (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPDT (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55 degrees F (-9.4 to 12.8 degrees C), factory set at 38 degrees F.

C. High Temperature Detectors (‘Firestat’) (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215 degrees F (-4 to 102 degrees C).

D. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150 degrees F (10 to 65 degrees C), and a minimum 10 degrees F fixed setpoint differential.

E. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed contacts, operating temperature range of 50 to 90 degrees F (10 to 32 degrees C), switch rating of 24 Vac (30 Vac maximum), and both manual and automatic fan operation in both the heat and cool modes.

F. Control Relays: All control relays shall be UL listed, with contacts rated for the application.

1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:

   a. Pilot light indication of power-to-coil.

   b. Coil rated for 50 and 60 Hz service.

   c. Acceptable Manufacturers: Relays shall be Functional Devices (RIB), Potter Brumfield, Model KRPA or approved equal.

2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 horsepower, and 1/3 horsepower, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC or approved equal.

3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.

4. All safety circuits shall be installed to operate individual interposing relays located in the associated equipment control panel. Each safety device (i.e. Freezestat, DP safety, smoke detector, firestat, etc.) wiring circuit shall be installed with individual homeruns back to the associated control panel. See control Drawings for details.

G. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA 1 enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse.

H. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. 120/24 VAC transformers shall be fused in accordance with the NEC. Transformer shall be properly sized for application, and mounted in minimum NEMA 1 enclosure.

    1. Transformers shall be manufactured by Westinghouse, Square ‘D’, Jefferson or approved equal.

I. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a NEMA 1 enclosure.

    1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.

    2. TDRs shall be UL and CSA listed, Crouzet type.

J. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley or approved equal.

K. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley or approved equal.

L. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory or approved equal.

M. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley or approved equal.

2.18 NAMEPLATES

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 inch thick, black, with white center core, and shall be minimum 1 inch x 3 inch, with minimum ¼ inch high block lettering. Nameplates for devices smaller than 1 inch x 3 inch shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

2.19 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is ±0.5 percent accurate, test equipment shall be ±0.25 percent accurate over same range).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in Drawings and details shown on Drawings. Install electrical components and use electrical products complying with requirements of the latest edition of the National Electrical Code and all local codes.

D. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. Wiring System: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with the latest edition of the National Electrical Code and Division 26. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with the latest edition of the National Electrical Code and Division 26.

3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.

4. All WAN and LAN patch cords shall be approved and installed as approved by owner.

5. Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide steel type connectors. Install wiring in galvanized rigid steel conduit at all exterior locations and where subjected to moisture. Install in PVC Schedule 40 conduit if encased in concrete. All conduits penetrating partitions, walls or floors shall be sealed with a submitted and approved fire/smoke sealant to prevent migration of air through the conduit system.

6. Communication wiring, signal wiring and low voltage control wiring may be run without conduit in concealed, accessible locations if noise immunity is ensured.

    a. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

    b. Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines.

    c. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties and not to exceed five (5) foot intervals.

    d. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct.

   e. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking.

7. Secondary LAN Communication cabling shall be provided in an Owner approved color dedicated to the BAS.

8. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation Drawings..

E. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

F. Averaging Temperature Sensors: Cover no more than two square feet per linear foot of sensor length except where indicated. Manufacturer recommended mounting clips shall be used to support and prevent any movement of the sensing probe in the air flow. Generally, where flow is sufficiently homogeneous/adequately mixed at sensing location, consult Engineer for requirements.

G. Fluid Flow Sensors: Install per manufacturer’s recommendations in an unobstructed straight length of pipe.

H. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

I. Water Differential Pressure Transmitters: Provide 5 valve bypass arrangement to protect against over pressure damaging the transmitter.

J. Steam Differential Pressure Transmitters: Install as shown on the Drawings per manufacturer’s instructions.

K. Pipe Surface Mount Temperature Sensors: Install with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe Contractor shall neatly cut insulation install sensor, repair or replace insulation and vapor barrier and adequately seal vapor barrier.

L. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

M. Current Switches for Motor Status Monitoring: Adjust so that set point is below minimum operating current and above motor no load current.

N. Supply Duct Pressure Transmitters:

1. General: Install pressure tips with at least four (4) ‘round equivalent’ duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer’s installation instructions. Locate the transmitter at an accessible location to facilitate calibration.

2. VAV System ‘Down-Duct’ Transmitters: Locate pressure tips as indicated on Drawings or as approved by Owner’s TAB Firm.

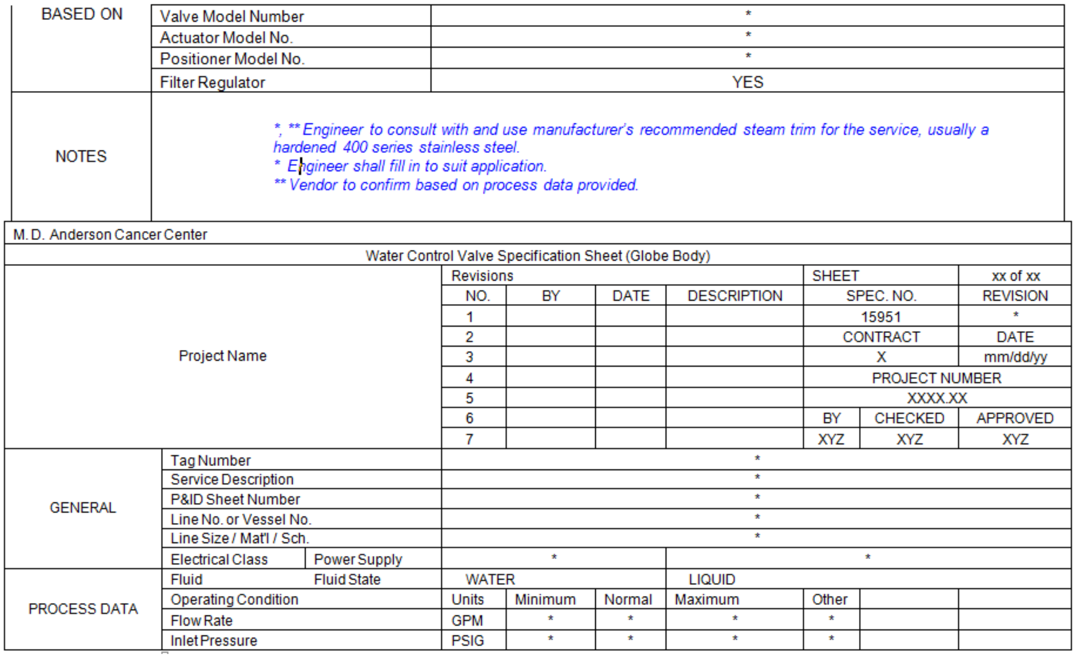
O. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

[For Critical Service Control Valve applications, Engineer shall complete the applicable following forms for each individual application and/or valve. Control valve sizing and selection is the initial responsibility of the Engineer and NOT left to the BAS Provider. The items noted with a * and *,** shall be completed by the Engineer to list the requirements of the valves for Cv, close off, temperature ratings, cage material, seat material, trim material etc. for each individual application. This should be a result of analyzing the valves performance and application across the range of control. Engineer shall consult with Owner prior to specifying these valves.]

M. D. Anderson Cancer Center							
Steam Control Valve Specification Sheet (Globe Body)							
Project Name	REVISIONS				SHEET		xx of xx
	NO.	BY	DATE	DESCRIPTION	SPEC. NO.		REVISION
	1				15951		*
	2				CONTRACT		DATE
	3				X		mm/dd/yy
	4				PROJECT NUMBER		
	5				XXXX.XX		
	6				BY	CHECKED	APPROVED
	7				XYZ	XYZ	XYZ

GENERAL	Tag Number		*						
	Service Description		*						
	P&ID Sheet Number		*						
	Line No. or Vessel No.		*						
	Line Size / Mat'l / Sch.		*						
	Electrical Class	Power Supply	*			*			
PROCESS DATA	Fluid	Fluid State	SATURATED STEAM <125 PSIG			VAPOR			
	Operating Condition		Units	Minimum	Normal	Maximum	Other		
	Flow Rate		LB/HR	*	*	*	*		
	Inlet Pressure		PSIG	*	*	*	*		
	Outlet Pressure		PSIG	*	*	*	*		
	Temperature		DEG F	*	*	*	*		
	Mol. Wt.								
	Sp. Wt	Sp. Grav							
	Viscosity	Sp Heat							
	Style	Size	GLOBE				xx"		
	End Connection	Rating	xx" RF FLANGED				ANSI CLASS 150		

BODY	Port Size	Travel	*	*
	Valve Cv	Valve C1/Km	*	**
	Body Matl.	Bonnet	ASTM A216 WCB	ASTM A216 WCB
	Characteristic	Trim Number	EQUAL PERCENTAGE	*,**
	Cage Matl.	Retainer Matl.	*	*
	Seat Matl.	Seat Ring Matl.	*,**	*,**
	Plug Matl.	Stem Matl.	*,**	*,**
BODY Cont.	Flow Action		DOWN	
	Gaskets		SPIRAL METALLIC	
	Stem Guide		**	
	Packing		GLASS FILLED PTFE**	
	Required Seat Tightness		ANSI CLASS IV	
	Max. Allowable Sound Level (dBA)		<75 dBA	
ACTUATOR	Type		PNEUMATIC	
	Size	Bench Set	*	*
	Push-Down To	Fail Position	CLOSE*	CLOSE*
	Close At	Open At	6 PSIG*	30 PSIG*
	Handwheel		NONE*	
POSITIONER	Type		Electronic	
	Communications Protocol		*	
	Input Signal	Output Signal	4-20 mA	
	Air Supply		80 PSIG NOMINAL*	
TRANSDUCER	Type		*	
	Input Signal		*	
	Output Signal		*	
OPTIONS	Air Set w/ Gauges		YES*	
	Solenoids		*	
	Position Switches		*	
SELECTION	Manufacturer		Fisher, Valtek, Dezurik-Copes, Leslie	



BASED ON	Valve Model Number	*
	Actuator Model No.	*
	Positioner Model No.	*
	Filter Regulator	YES
NOTES	**, ** Engineer to consult with and use manufacturer's recommended steam trim for the service, usually a hardened 400 series stainless steel.* ** Engineer shall fill in to suit application.* *** Vendor to confirm based on process data provided.*	

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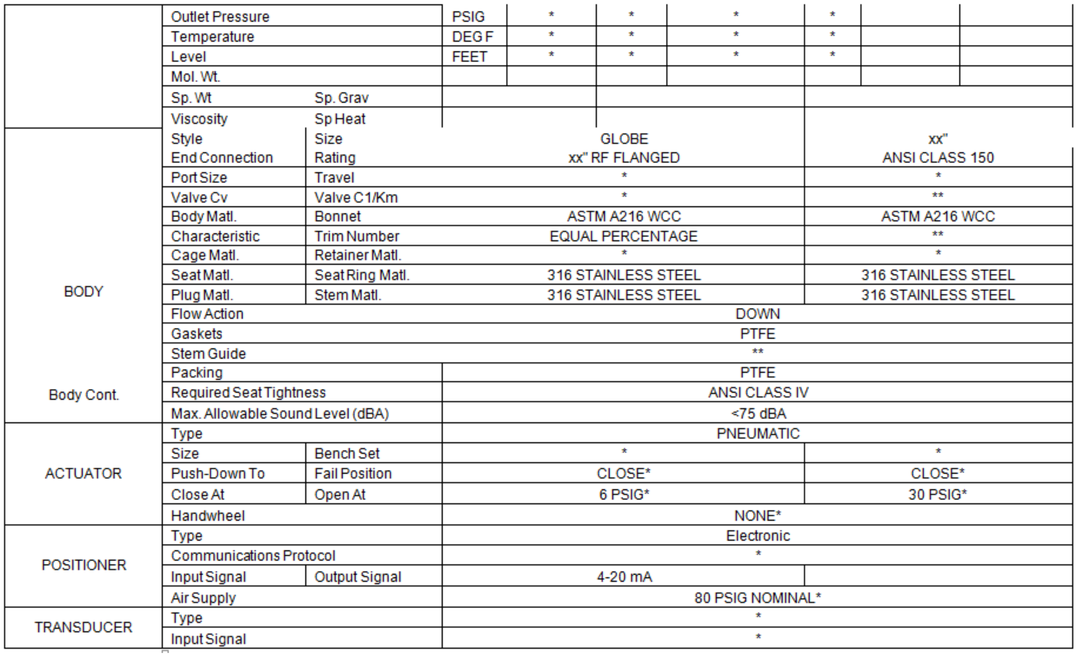
Water Control Valve Specification Sheet (Globe Body)

Project Name	Revisions				SHEET		xx of xx
	NO.	BY	DATE	DESCRIPTION	SPEC. NO.		REVISION
	1				15951		*
	2				CONTRACT		DATE
	3				X		mm/dd/yy
	4				PROJECT NUMBER		
	5				XXXX.XX		
	6				BY	CHECKED	APPROVED
	7				XYZ	XYZ	XYZ

GENERAL	Tag Number		*						
	Service Description		*						
	P&ID Sheet Number		*						
	Line No. or Vessel No.		*						
	Line Size / Mat'l / Sch.		*						
	Electrical Class	Power Supply	*			*			
PROCESS DATA	Fluid	Fluid State	WATER			LIQUID			
	Operating Condition		Units	Minimum	Normal	Maximum	Other		
	Flow Rate		GPM	*	*	*	*		
	Inlet Pressure		PSIG	*	*	*	*		



	Outlet Pressure		PSIG	*	*	*	*		
	Temperature		DEG F	*	*	*	*		
	Level		FEET	*	*	*	*		
	Mol. Wt.								
	Sp. Wt	Sp. Grav							
	Viscosity	Sp Heat							

BODY	Style	Size	GLOBE	xx"
	End Connection	Rating	xx" RF FLANGED	ANSI CLASS 150
	Port Size	Travel	*	*
	Valve Cv	Valve C1/Km	*	**
	Body Matl.	Bonnet	ASTM A216 WCC	ASTM A216 WCC
	Characteristic	Trim Number	EQUAL PERCENTAGE	**
	Cage Matl.	Retainer Matl.	*	*
	Seat Matl.	Seat Ring Matl.	316 STAINLESS STEEL	316 STAINLESS STEEL
	Plug Matl.	Stem Matl.	316 STAINLESS STEEL	316 STAINLESS STEEL
	Flow Action		DOWN	
	Gaskets		PTFE	
	Stem Guide		**	
	Packing		PTFE	
Body Cont.	Required Seat Tightness		ANSI CLASS IV	
	Max. Allowable Sound Level (dBA)		<75 dBA	
ACTUATOR	Type		PNEUMATIC	
	Size	Bench Set	*	*
	Push-Down To	Fail Position	CLOSE*	CLOSE*
	Close At	Open At	6 PSIG*	30 PSIG*
	Handwheel		NONE*	
POSITIONER	Type		Electronic	
	Communications Protocol		*	
	Input Signal	Output Signal	4-20 mA	
	Air Supply		80 PSIG NOMINAL*	
TRANSDUCER	Type		*	
	Input Signal		*	

	Output Signal	*
OPTIONS	Air Set w/ Gauges	YES*
	Solenoids	*
	Position Switches	*
SELECTION BASED ON	Manufacturer	Fisher, Valtek, Dezurik-Copes, Leslie
	Valve Model Number	*
	Actuator Model No.	*
	Positioner Model No.	*
	Filter Regulator	YES
NOTES	**Engineer shall fill in to suit application.* *** Vendor to confirm based on process data provided.*	

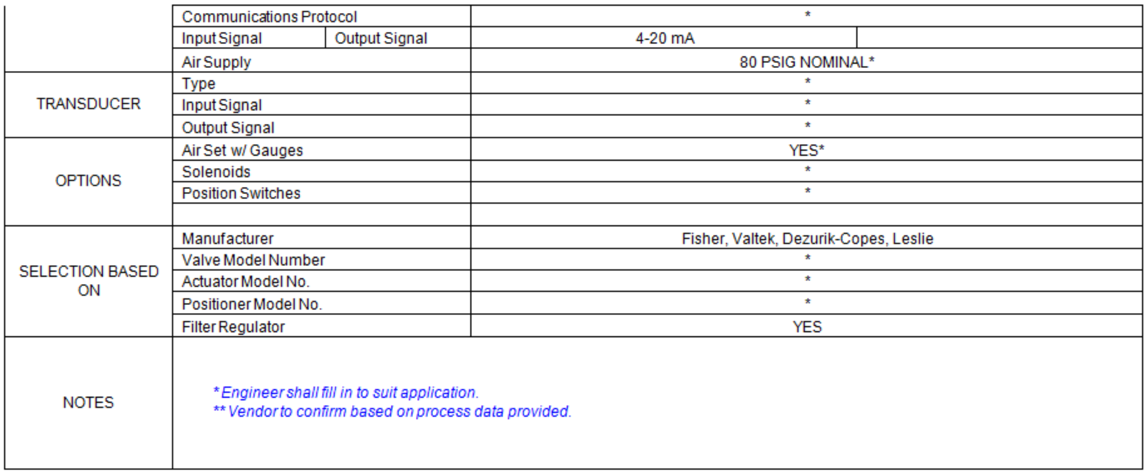
M. D. Anderson Cancer Center

Water Control Valve Specification Sheet (Globe Body)

Project Name	Revisions				SHEET		xx of xx
	NO.	BY	DATE	DESCRIPTION	SPEC. NO.		REVISION
	1				15951		*
	2				CONTRACT		DATE
	3				X		mm/dd/yy
	4				PROJECT NUMBER		
	5				XXXX.XX		
	6				BY	CHECKED	APPROVED
	7				XYZ	XYZ	XYZ

GENERAL	Tag Number	*
	Service Description	*
	P&ID Sheet Number	*
	Line No. or Vessel No.	*
	Line Size / Mat'l / Sch.	*

	Electrical Class	Power Supply	*			*			
PROCESS DATA	Fluid	Fluid State	WATER			LIQUID			
	Operating Condition		Units	Minimum	Normal	Maximum	Other		
	Flow Rate		GPM	*	*	*	*		
	Inlet Pressure		PSIG	*	*	*	*		
	Outlet Pressure		PSIG	*	*	*	*		
	Temperature		DEG F	*	*	*	*		
	Level		FEET	*	*	*	*		
	Mol. Wt.								
	Sp. Wt	Sp. Grav							
	Viscosity	Sp Heat							
BODY	Style	Size	GLOBE				xx"		
	End Connection	Rating	xx" RF FLANGED				ANSI CLASS 150		
	Port Size	Travel	*				*		
	Valve Cv	Valve C1/Km	*				**		
	Body Matl.	Bonnet	ASTM A216 WCC				ASTM A216 WCC		
	Characteristic	Trim Number	EQUAL PERCENTAGE				**		
	Cage Matl.	Retainer Matl.	*				*		
	Seat Matl.	Seat Ring Matl.	316 STAINLESS STEEL				316 STAINLESS STEEL		
	Plug Matl.	Stem Matl.	316 STAINLESS STEEL				316 STAINLESS STEEL		
	Flow Action		DOWN						
	Gaskets		PTFE						
	Stem Guide		**						
	Packing		PTFE						
Body Cont.	Required Seat Tightness		ANSI CLASS IV						
	Max. Allowable Sound Level (dBA)		<75 dBA						
ACTUATOR	Type		PNEUMATIC						
	Size	Bench Set	*				*		
	Push-Down To	Fail Position	CLOSE*				CLOSE*		
	Close At	Open At	6 PSIG*				30 PSIG*		
	Handwheel		NONE*						
POSITIONER	Type		Electronic						



	Communications Protocol		*	
	Input Signal	Output Signal	4-20 mA	
	Air Supply		80 PSIG NOMINAL*	
TRANSDUCER	Type		*	
	Input Signal		*	
	Output Signal		*	
OPTIONS	Air Set w/ Gauges		YES*	
	Solenoids		*	
	Position Switches		*	
SELECTION BASED ON	Manufacturer		Fisher, Valtek, Dezurik-Copes, Leslie	
	Valve Model Number		*	
	Actuator Model No.		*	
	Positioner Model No.		*	
	Filter Regulator		YES	
NOTES	*Engineer shall fill in to suit application. ** Vendor to confirm based on process data provided.			

END OF SECTION 25 55 00 00c

SECTION 25 55 00 00d - BAS FIELD PANELS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Section includes:

1. Building Controller (BC).
2. Advance Application Specific Controller (AAC).
3. Application Specific Controller (ASC).

B. Furnish and install DDC Control units and/or Smart Devices required to support specified building automation system functions.

C. Refer to Section 25 00 00 - Building Automation System (BAS) General for general requirements.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. The BAS and digital control and communications components installed, as Work of this Contract shall be an integrated distributed processing.

1. All access, programming, alarming, system configuration shall be utilized from the existing system software and database without any third party programs or gateways.

2.03 STAND-ALONE FUNCTIONALITY

A. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category specified in this Section. This item refers to acceptable paradigms for associating the points with the processor.

B. Functional Boundary:

1. Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the Contract Documents.

2. Systems specified for the Application Category will dictate the boundary of the standalone control functionality. See related restrictions below.

3. When referring to the controller as it pertains to the standalone functionality, reference is specifically made to the processor.

4. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.

C. The following configurations are considered acceptable with reference to a controller's standalone functionality:

1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).

2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.

3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.

D. The following configurations are considered unacceptable with reference to a controller's standalone functionality:

1. I/O point expansion devices connected to the main controller board via wiring and as such may be remote from the controller and that communicate via a sub LAN protocol.

2. Multiple controllers enclosed in the same control panel to accomplish the point requirement.

2.04 BUILDING CONTROLLER (BC)

A. General Requirements:

1. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces.

2. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions.

3. BCs shall share information with the entire network of BCs for full global control directly without requiring other BCs, LAN devices, Local Supervisory LAN gateways, routers etc. to assist, perform, or act as an intermediate device for communicating.

4. Each controller shall permit multi-user operation from multiple workstations and portable operator terminals connected either locally or over the Primary Controller LAN. Each unit shall have its own internal RAM, non-volatile memory, microprocessor, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure.

5. BCs shall be programmable from an operator workstation, portable operator terminal, or hand held operating device. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.

6. BCs shall be connected to a controller network that qualifies as a Primary Controlling LAN.

7. All BCs shall be protected from any memory loss due to a loss of power by one or a combination of the following:

   Volatile RAM shall have a battery backup using a lithium battery with a rated service life of fifty (50) hours, and a rated shelf life of at least five (5) years. Self-diagnostic routine shall report an alarm for a low battery condition.

   EEPROM, EPROM, or NOVROM non-volatile memory.

8. In addition, BCs shall provide intelligent, standalone control of HVAC functions. Each BC shall be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices. Refer to standalone functionality specified above.

9. The BC shall provide for point mix flexibility and expandability. This requirement may be met via either a family of expander boards, modular input/output configuration, or a combination thereof. Refer to stand alone functionality specified above.

10. All BC point data, algorithms and application software shall be modifiable from the Operator Workstation.

11. Each BC shall execute application programs, calculations, and commands via a microprocessor resident in the BC. The database and all application programs for each BC shall be stored in non-volatile or battery backed volatile memory within the BC and will be able to upload/download to/from the OWS and/or CSS.

12. BC shall provide buffer for holding alarms and messages. Alarms and messages shall reside in a buffer within the controller and be delivered up to the CSS via the LAN when the buffer is full or when scheduled.

13. BC shall provide buffer for holding trends. Trends shall reside in a buffer within the controller and be delivered up to the CSS via the LAN when the buffer is full or when scheduled.

14. Each BC shall include self-test diagnostics, which allow the BC to automatically alarm any malfunctions, or alarm conditions that exceed desired parameters as determined by programming input.

15. Each BC shall contain software to perform full DDC/PID control loops.

16. For systems requiring end-of-line resistors those resistors shall be located in the BC.

17. Input-Output Processing:

    Digital Outputs (DO):

    1) Outputs shall be rated for a minimum 24 Vac or Vdc, 1 amp maximum current. Each shall be configurable as normally open or normally closed.

    2) Each output shall have an LED to indicate the operating mode of the output and a manual hand off or auto switch to allow for override. Provide feedback to remotely indicate the HOA is not in the Auto position. If these HOA switches are not provided on the main board they shall be provided via isolation relays within the control enclosure.

3) Each DO shall be discrete outputs from the BC’s board (multiplexing to a separate manufacturer’s board is unacceptable). Provide suppression to limit transients to acceptable levels.

Analog Inputs (AI):

4) AI shall be O-5 Vdc, 0-10 Vdc, 0-20 Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input.

5) Each input shall be a discrete input to the BC’s board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise).

6) A/D converters shall have a minimum resolution of twelve (12) bits.

Digital Inputs (DI):

7) Monitor dry contact closures.

8) Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board.

Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

Electronic Analog Outputs (AO):

9) Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection.

10) Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with Owner approval (Generally these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops).

11) Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC’s board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of ten (10) bits.

Analog Output Pneumatic (AOP), 0-20 psi:

12) Pneumatic outputs via an I/P transducer, or digital to pneumatic transducer are acceptable.

13) Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the BC and provide individual feedback.

14) Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

Pulsed Inputs:

15) Capable of counting up to eight (8) pulses per second with buffer to accumulate pulse count.

16) Pulses shall be counted at all times.

18. A communication port for operator interface through a terminal shall be provided in each BC. It shall be possible to perform all program and database back-up, system monitoring, control functions, and BC diagnostics through this port. Standalone BC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or workstations.

19. Each BC shall be equipped with loop tuning algorithm for precise proportional, integral, derivative (PID) control. Loop tuning tools provided with the Operator Workstation software is acceptable. In any case, tools to support loop tuning must be provided such that P, I, and D gains are automatically calculated.

20. All analog output points shall have a selectable failure setpoint. The BC shall be capable of maintaining this failure setpoint in the event of a system malfunction, which causes loss of BC control, or loss of output signal, as long as power is available at the BC. The failure setpoint shall be selectable on a per point basis.

21. Slope intercepts and gain adjustments shall be available on a per-point basis.

22. BC Power Loss:

    Upon a loss of power to any BC, the other units on the primary controlling network shall not in any way be affected.

    Upon a loss of power to any BC, the battery backup shall ensure that the energy management control software, the Direct Digital Control software, the database parameters, and all other programs and data stored in the RAM are retained for a minimum of fifty (50) hours. An alarm diagnostic message shall indicate that the BC is under battery power.

    Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.

    Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall automatically report the condition (upon resumption of power) and be capable of receiving a download via the network, and connected computer. In addition, The University shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the memory of each BC to the operator workstation via the local area network, or via the telephone line dial-up modem where applicable, or to the laptop PC via the local RS-232C port.

23. BC Failure:

    Building Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either last value or a specified value. Peer BCs shall recognize the loss, report alarm and reconfigure the LAN.

    BC Hardware Failure: BC shall cease operation and terminate communication with other devices. All outputs shall go to their specified fail position.

24. Each BC shall be equipped with firmware resident self-diagnostics for sensors and be capable of assessing an open or shorted sensor circuit and taking an appropriate control action (close valve, damper, etc.).

25. BCs may include LAN communications interface functions for controlling secondary controlling LANs Refer to Section 25 30 00 - BAS System Communications Devices for requirements if this function is packaged with the BC.

26. A minimum of four (4) levels of password protection shall be provided at each BC.

27. BCs shall be mounted in packaged equipment enclosures, or locking wall mounted in an enclosure, as specified elsewhere.

28. In the last month of the Warranty Period, all controller firmware, software, drivers, etc. will be upgraded to the latest release (version) in effect at the end of the Warranty Period.

29. All BC naming conventions shall adhere to the format as established by The University's Standard Acronyms document.

B. BACnet Building Controller Requirements:

1. The BC(s) shall support all BIBBs defined in the BACnet Building Controller (B-BC) device profile as defined in the BACnet standard.

2. BCs shall communicate over the BACnet Building Controller LAN.

3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.

2.05 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)

A. General Requirements:

1. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment. Each unit shall have its own internal RAM, non-volatile memory and will continue to operate all local control functions in the event of a loss of communications on the ASC LAN or sub-LAN. Refer to standalone requirements by application specified in this Section. In addition, it shall be able to share information with every other BC and AAC /ASC on the entire network.

2. Each AAC and ASC shall include self-test diagnostics that allow the AAC /ASC to automatically relay to the BC, LAN Interface Device or workstation, any malfunctions or abnormal conditions within the AAC /ASC or alarm conditions of inputs that exceed desired parameters as determined by programming input.

3. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.

4. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, minimum eight (8) bit A to D conversion, voltage transient and lightning protection devices. All volatile memory shall have a battery backup of at least fifty (50) hours with a battery life of five (5) years.

5. All point data; algorithms and application software within an AAC /ASC shall be modifiable from the Operator Workstation.

6. In the last month of the Warranty Period, all controller firmware, software, drivers, etc. will be upgraded to the latest release (version) in effect at the end of the Warranty Period.

7. AAC and ASC Input-Output Processing

Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each DO shall be discrete outputs from the AAC/ASC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.

Analog Inputs (AI): AI shall be O-5 Vdc, 0-10Vdc, 0-20Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of eight to ten bits depending on application.

Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board.

Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

Electronic Analog Outputs (AO) as required by application:

1) Voltage mode, 0-5VDC and 0-10VDC; current mode (4-20 mA). Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with Owner approval (Generally, PWM will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.).

2) Where PWM is allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturers board is unacceptable).

3) D/A converters shall have a minimum resolution of eight (8) bits.

Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, PWM/P transducer, or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the AAC /ASC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

B. BACnet AAC(s) and ASC(s) Requirements:

1. The AAC(s) and ASC(s) shall support all BIBBs defined in the BACnet Building Controller (B-AAC and B-ASC) device profile as defined in the BACnet standard.
2. AAC(s) and ASC(s) shall communicate over the BACnet Building Controller LAN or the ASC LAN or sub-LAN.
3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.

C. Terminal Unit Controllers:

1. Terminal unit controllers controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis.
2. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded.
3. The software shall select scheduled terminal units randomly and shall not allow more than 5 percent of the total quantity of controllers in a building to perform this function at the same time. When possible the controllers shall perform this function when the supply or exhaust air system is not operating or is unoccupied.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

3.03 SYSTEM ACCESS

A. Provide an Ethernet connection and a 5 port hub at each panel housing a controller or controllers that provides access to the Local Supervisory LAN and to the Control System Server for all Controllers, other than an Application Category 1 Controllers. The user shall be able to access each controller on the system using this connection via the Control System Server database for graphics, schedules, programming, controller configuration etc.

3.04 HARDWARE APPLICATION REQUIREMENTS

A. General:

1. The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions.

2. A Building Controller as specified above is generally fully featured and customizable whereas the AAC/ASC refers to a more cost-effective unit designed for lower-end applications. Specific requirements indicated below are required for the respective application. Manufacturer may apply the most cost-effective unit that meets the requirement of that application.

B. Standalone Capability:

1. Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment.

2. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs or SDs via LAN.

C. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.

D. Application Category 0 (Distributed Monitoring):

1. Applications in this category include the following:

   Monitoring of variables that are not used in a control loop, sequence logic, or safety.

2. Points on BCs, AACs, and ASCs may be used in these applications as well as SDs and/or general-purpose I/O modules.

3. Where these points are trended, Contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.

Delete equipment that is not applicable – do not move equipment types from one category to another.

E. Application Category 1 (Application Specific Controller):

1. Applications in this category include the following:

Fan Coil Units.

Airflow Control Boxes (VAV and Constant Volume Terminal Units).

Miscellaneous Heaters.

Unitary equipment <15 tons (Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, Water-Source Heat Pumps).

Induction Units.

Dual Duct Zone Dampers.

2. ASCs may be used in these applications.

3. Standalone Capability:

Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control.

Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred.

If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Value
Scheduling Period	Normal
Morning Warm-Up	Off (cold discharge air)
Load Shed	Off (no shedding)
Summer/Winter	Winter
Trend Data	N/A
[Smoke Pressurization Mode]	[Normal Mode]

4. Mounting:

ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.

ASCs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.

ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.

BAS Provider may furnish ASCs to the terminal unit manufacturer for factory mounting.

5. Programmability: Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings. Application-specific block control algorithms may be used to meet the sequence of operations. The ability to customize the control algorithm is not required unless specifically indicated otherwise.

6. LAN Restrictions: For networks operating at 38.4 kbps or less, limit the number of nodes on the network to meet all system performance criteria and to no more than 80 percent of the maximum recommended by the manufacturer. For networks operating at greater than 38.4 kbps limit the number of nodes on the network to meet all system performance criteria up to the maximum recommended by the manufacturer.

Delete equipment that is not applicable – do not move equipment types from one category to another.

F. Application Category 2 (General Purpose Terminal Controller):

Applications in this category include the following:

Unitary Equipment >= 15 tons (Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units, and similar).

Small, Constant Volume Single Zone Air Handling Units.

Constant Volume Pump Start/Stop.

Miscellaneous Equipment (Exhaust Fan) Start/Stop.

Miscellaneous Monitoring (not directly associated with a control sequence and where trending is not critical).

1. BCs may be used in these applications.

2. ASC's may be used in these applications provided the ASC meets all requirements specified below. This category requires a general-purpose ASC to which application-specific control algorithms can be attached.

3. Standalone Capability:

Only the following data (as applicable) may be acquired from other ASCs via LANs.

In the event of a loss of communications with any other ASCs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC/ASC shall use the last value obtained before the fault occurred.

If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Delay Time	Default Value
Outside Air Temperature	3 minutes	80°F
Outside Air Humidity	3 minutes	60% RH
Outside Air Enthalpy	3 minutes	30 Btu/lb
Trend Data	3 minutes	N/A
Cooling/Heating Requests	3 minutes	None
[Smoke Pressurization Mode]	[3 minutes]	[Normal Mode]
[Smoke Exhaust Command]	[3 minutes]	[Normal Mode]

4. Mounting:

ASCs that control equipment located above accessible ceilings shall be mounted on the equipment and shall be rated for plenum use.

ASCs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the Contractor) or in a nearby mechanical/utility room in which case it shall be enclosed in a NEMA 1, locking enclosure.

5. Programmability:

Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings.

Operator shall be able to address and configure spare inputs for monitoring.

Operator shall be able to address and configure spare outputs for simple single loop control actions or event initiated actions.

Application-specific block control algorithms shall be used to meet the sequence of operations. The ability to customize the control algorithm is not required unless specifically indicated otherwise.

6. LAN Restrictions: Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 32.

Delete equipment that is not applicable – do not move equipment types from one category to another.

G. Application Category 3 (Advanced Application Controller):

1. Applications in this category include the following:

Steam Pressure Reducing Station Control.

Steam Converter Control.

Large Constant Volume Air Handlers.

VAV Air Handlers.

Dual Duct Air Handlers.

Multizone Air Handlers.

Self-Contained VAV Units.

Air Handlers serving critical areas.

Central Cooling Plant.

Central Heating Plant.

Cooling Towers.

Sequenced or Variable Speed Pump Control.

Local Chiller Control (unit specific).

Campus Loop Chilled Water Control.

2. BCs shall be used in these applications.

3. LAN Restrictions: Comply with Part Two requirements, Stand-Alone Functionality.

3.05 CONTROL UNIT REQUIREMENTS

A. Refer to Section 25 00 00 for requirements pertaining to control unit quantity and location.

END OF SECTION 25 55 00 00d

SECTION 25 55 00 00e - BAS SOFTWARE AND PROGRAMMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Section Includes:

1. System Software.
2. Programming Description.
3. Control Algorithms.
4. Energy Management Applications.
5. Password Protection.
6. Alarm Reporting.
7. Trending.
8. Data Acquisition and Storage.
9. Point Structuring.
10. Dynamic Color Graphics.

B. Fully configure systems and furnish and install all software, programming and dynamic color graphics for a complete and fully functioning system as specified.

C. Refer to Section 25 00 00 - Building Automation System (BAS) General for general requirements as well as requirements for interface with Owner’s WAN.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

1.04 LICENSING

A. Provide or upgrade all licensing for all software packages at all required workstations. BAS licensing shall allow unlimited simultaneous users for access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing. All operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to The University.

B. All software should be available on all Operator Workstations or CSSs provided, and on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least two (2) sets of CDs shall be provided with backup software for all software provided, so that The University may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses.

C. Provide licensing and original software copies for each OWS or CSS.

D. Provide licensing and original software copies for each remote graphic workstation. Licenses for remote graphic workstations shall allow for access to any Site and shall not be restricted to accessing only the LANs included in this Project.

E. In the last month of the Warranty Period, upgrade all software and firmware packages to the latest release (version) in effect at the end of the Warranty Period.

F. Refer to Section 25 00 00 - Building Automation System (BAS) General for further requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 SYSTEM SOFTWARE-GENERAL

A. Functionality and Completeness: Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.

B. Configuration: The software shall support the system as a distributed processing network configuration.

2.03 CONTROLLER SOFTWARE

A. BC Software Residency: Each BC as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:

1. Real-Time Operating System software.
2. Real-Time Clock/Calendar and network time synchronization.
3. BC diagnostic software.
4. LAN Communication software/firmware.
5. Direct Digital Control software.

6. Alarm Processing and Buffering software.
7. Energy Management software.
8. Data Trending, Reporting, and Buffering software.
9. I/O (physical and virtual) database.
10. Remote Communication software.

B. AAC/ASC Software Residency: Each AAC/ASC as defined below shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Section 25 30 00) with the restrictions/exceptions per application provided in Section 25 14 00:

1. Real-Time Operating System software.
2. AAC/ASC diagnostic software.
3. LAN Communication software.
4. Control software applicable to the unit it serves that will support a single mode of operation.
5. I/O (physical and virtual) database to support one mode of operation.

C. Stand Alone Capability: BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Section 25 14 00 for other aspects of standalone functionality.

D. Operating System: Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Section 25 14 00 for other aspects of the controller’s operating system.

E. Network Communications: Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:

1. Building Controller/Primary LAN shall be a high-speed network designed and optimized for control system communication. If a Primary LAN communications trunk is severed, BCs shall reconfigure into two separate LANs and continue operations without interruption or Operator intervention.
2. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
3. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

F. Point Database/Summary Table:

1. All points included in the typical equipment point list must be represented to Owner's WAN in a common, open protocol format. All points should be provided as BACnet standard analog, binary, schedule, or trend objects. Naming conventions for these points and network addressing are discussed in Part Three of this Section.

2. Point/system database creation and modification shall be via a user-friendly, menu-driven program. System software shall support virtual or logic point (points not representing a physical I/O) creation. Software shall support virtual points with all services specified herein. Database software shall support definition of all parameters specified in Part Three of this Section for a given point type. If database does not support all these parameters, software module shall be created and attached to the points which accomplish the respective function.

G. Diagnostic Software: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions

H. Alarm/Messaging Software: Controller software shall support alarm/message processing and buffering software as more fully specified below.

I. Application Programs: CUs shall support and execute application programs as more fully specified below:

1. All Direct Digital Control software, Energy Management Control software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) Owner programming.

2. Line programs shall supply preprogrammed functions to support these energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.

J. Security: Controller software shall support multiple level password access restriction as more fully specified below.

K. Direct Digital Control: Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:

1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output.

2. Two Position control (Hi or Low crossing with deadband).

3. Single-Pole Double-Throw relay.

4. Delay Timer (delay-on-make, delay-on-break, and interval).

5. Hi/Low Selection.

6. Reset or Scaling Module.

7. Logical Operators (And, Or, Not, Xor).

L. Psychrometric Parameters: Controller software shall provide preprogrammed functions to calculated and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.

M. Updating/Storing Application Data: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS or CSS connected locally, to the Primary LAN, to the Local Supervisory LAN and remotely via the internet and modem and telephone lines as applicable but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.

N. Restart: System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.

O. Time Synchronization: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network, or all devices simultaneously. Automatic time synchronization shall be provided.

P. Miscellaneous Calculations: System software shall automate calculation of psychometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

2.04 APPLICATION PROGRAMMING DESCRIPTION

A. The application software shall be user programmable.

B. This Specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:

1. Point Definition: provide templates customized for point type, to support input of individual point information. Use standard BACnet Objects as applicable.
2. Graphical Block Programming: Manipulation of graphic icon ‘blocks’, each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
3. Functional Application Programming: Pre-programmed application specific programs that allow/require limited customization via ‘fill-in-the-blanks’ edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
4. Line Programming: Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.

C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

2.05 ENERGY MANAGEMENT APPLICATIONS

A. System shall have the ability to perform all of the following energy management routines via preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:

1. Time-of-Day Scheduling.
2. Calendar-Based Scheduling.
3. Holiday Scheduling.
4. Temporary Schedule Overrides.
5. Optimal Start/Optimal Stop-based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum.

6. Night Setback and Morning Recovery Control, with ventilation only during occupancy.

7. Economizer Control (enthalpy or dry-bulb).

8. Peak Demand Limiting / Load Shedding.

9. Dead Band Control.

B. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization.

2.06 PASSWORD PROTECTION

A. Multiple-level password access protection shall be provided to allow The University’s authorized BAS Administrator to limit workstation control, display and database manipulation capabilities as BAS Administrator deems appropriate for each user, based upon an assigned user name with a unique password.

B. All passwords for the system shall be provided to The University including administrator, dealer, or factory level passwords for the systems provided under this Project.

C. Passwords shall restrict access to all Control Units.

D. Each user name shall be assigned to a discrete access level. A minimum of four (4) levels of access shall be supported. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user.

E. A minimum of 250 user names shall be supported per Owner’s direction.

F. Operators shall be able to perform only those commands available for the access level assigned to their user name.

G. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving interface device software on-line.

2.07 ALARM AND EVENT MANAGEMENT REPORTING

A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. Each BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall a BCs ability to report alarms be affected by either operator activity at an Operator Workstation or local handheld device, or by communications with other panels on the network.

1. Alarm Descriptor: Each alarm or point change shall include that point’s English language description, and the time and date of occurrence. In addition to the alarm’s descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.

2. Alarm Prioritization:

   a. The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels.

   b. A minimum of five (5) priority levels shall be provided. For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition.

c. All alarms shall display at the appropriate workstation alarm screen and each shall be assigned with the correct color and numeric value of priority.

d. Attention needs to be considered where instantaneous on / off alarms may occur and defined as being nuisance alarms. These types of alarms that activate and deactivate in a short time period shall be delayed or enhanced in such a way to prevent them from becoming nuisance alarms.

e. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with The University on establishing alarm priority definitions.

3. Alarm Report Routing: Each alarm shall be associated with a priority level and unique user-defined list of operator devices including any combination of local or remote workstations, printers, workstation disk files, e-mail addresses, and pagers. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.

4. Auto-Dial Alarm Routing: For alarm priority levels that include a remote workstation (accessed by modem) as one of the listed reporting destinations, the BC shall initiate a call to report the alarm, and shall terminate the call after alarm reporting is complete. System shall be capable of multiple retries and buffer alarms until a connection is made. If no connection is made, system shall attempt connection to an alternate dial-up workstation. System shall also be able to dial multiple pagers upon alarm activation.

5. Alarm Acknowledgment: For alarm priority levels that are directed to a workstation screen, an indication of alarm receipt shall be displayed immediately regardless of the application in use at the workstation, and shall remain on the screen until acknowledged by a user having a password that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and user name of acknowledging operator) shall be stored in a selected file on the workstation hard disk.

B. It shall be possible for any operator to receive a summary of all alarms regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; based on the particular event algorithm (e.g., change of value, change of state, out of range, and so on); alarm priority; and notification class.

C. Alarming Services:

1. All alarms and events shall be implemented using standard BACnet event detection and notification mechanisms. The workstation shall receive BACnet alarm and event notifications from any gateway or BACnet controller in the system and display them to an operator.

2. The alarm shall be linked to the system graphic it corresponds to. Either intrinsic reporting or algorithmic change reporting may be used but the intrinsic reporting method is preferred.

3. The workstation shall also log alarms and events, provide a way for an operator with sufficient privilege to acknowledge alarms, and log acknowledgements of alarms. It shall be possible for an operator to receive, at any time, a summary of all alarms that are currently in effect at any Site whether or not they have been acknowledged. Operators shall also be able to view and change alarm limits for any alarm at the appropriate password level

D. Alarm Historical Database: The database shall store all alarms and events object occurrences in an ODBC or an OLE database-compliant relational database. Provide a commercially available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows Data Services.

E. Submit all alarms per Section 25 00 00.

2.08 TRENDING

A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:

1. Provide trends for all physical points, virtual points and calculated variables.

2. BACnet Trend Objects are required and all trend data shall be stored in relational database format as specified in herein under Data Acquisition and Storage.

3. In the graphical format, the trend shall plot at least four (4) different values for a given time period superimposed on the same graph. The four (4) values shall be distinguishable by using unique colors. In printed form the four (4) lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.

4. The sample rate and data selection shall be selectable by the operator.

5. The trended value range shall be selectable by the operator.

6. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.

B. Control Loop Performance Trends: Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.

C. Data Buffering and Archiving: Trend data shall be buffered at the BC, and uploaded to hard disk storage when archival is desired. All archived trends shall be transmitted to the on-Site OWS or CSS as applicable. Uploads shall occur based upon a user-defined interval, manual command, or automatically when the trend buffers become full.

D. Time Synchronization: Provide a time master that is installed and configured to synchronize the clocks of all BACnet devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time (UTC). All trend sample times, both BACnet and LonTalk, shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

E. Submit all Trends per Section 25 00 00.

2.09 DYNAMIC PLOTTING

A. Provide a utility to dynamically plot in real-time at least four (4) values on a given 2-dimensional dynamic plot/graph with at least two Y-axes. At least five (5) dynamic plots shall be allowed simultaneously.

2.10 DATA ACQUISITION AND STORAGE

A. All points included in the typical equipment point list must be represented in a common, open or accessible format. All points should be provided as BACnet standard analog, binary, schedule, or trend objects. Naming conventions for these points and network addressing are discussed in the ‘Point Naming Conventions’ paragraph below.

B. Data from the BAS shall be stored in relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any additional data points, which are added to the BAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.

C. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS.

D. The database shall be ODBC or OLE database compliant. Provide a commercially-available ODBC driver or OLE database data provider, which would allow applications to access the data via Microsoft Windows standard data access services.

2.11 TOTALIZATION

A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.

B. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.

C. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

2.12 EQUIPMENT SCHEDULING

A. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.

B. All operators shall be able to view the entries for a schedule. Operators with sufficient privilege shall be able to modify schedule entries from any workstation.

C. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.

D. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the master schedules.

E. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first. A password level that does not allow assignment of master schedules shall allow a timed override feature.

F. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

2.13 POINT STRUCTURING AND NAMING

A. General:

1. The intent of this Section is to require a consistent means of naming points across The University's WAN. Contractor shall configure the systems from the perspective of The University's WAN, not solely the local Project.

2. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like.

3. The convention is tailored towards The University's WAN and as such, the interface shall always use this naming convention.

4. Native BACnet systems shall also use this naming convention. For non-BACnet systems, the naming convention shall be implemented as much as practical, and any deviations from this naming convention shall be approved by The University.

5. Each controller shall have English language descriptors for all system points, variables, parameters etc. located and accessible form the controller memory. All point naming shall match between all system files and record documents.

B. Point Summary Table:

1. The term ‘Point’ is a generic description for the class of object represented by analog and binary inputs, outputs, and values.

2. With each schematic, Contractor shall provide a Point Summary Table listing:

    a. Building code.

    b. Floor code.

    c. Room number.

    d. Sub room letter.

    e. Equipment type.

    f. Equipment number.

    g. Equipment code.

    h. Full point name (see Point Naming Convention paragraph).

    i. Point description.

    j. Ethernet backbone network number.

    k. Network number.

    l. Device ID.

    m. Device MAC address.

    n. Object ID (object type, instance number).

    o. Engineering units.

3. Additional fields for non-BACnet systems shall be appended to each row. Point Summary Table shall be provided in both hard copy and in electronic format (ODBC-compliant).

4. Point Summary Table shall also illustrate Network Variables/BACnet Data Links.

5. The BAS Provider shall coordinate with The University’s representative to compile and submit a proposed Point Summary Table for review prior to any object programming or Project startup. The Contractor shall support and not impede direct negotiations between the BAS Provider and The University to allow the customizing necessary for structuring the BAS point names to meet The University’s needs. The University shall grant approval of final point names to be verified through Commissioning by issuing the approved alarms to the Contractor.

6. The Point Summary Table shall be kept current throughout the duration of the Project by the Contractor as the Master List of all points for the Project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to The University the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the Commissioning process.

7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of Device ID-to-point information would be more efficient, the single line format is required as a single master table that will reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.

Point Summary Table - Example	
(Transpose for a single point per row format)	
Building Code	M1 (Medical School Unit 1)
Floor Code	04
Room Number	1000
Sub room letter	a
Equipment Type	Air Handler (AH)
Equipment Number	31
Equipment Code	SAT
*POINT NAME (OBJECT NAME)	AC04.1000a.AH31.SAT
*Point Description (Object Description)	AH31 Supply Air Temperature
Ethernet Network Number	600
Network Number	610
Device ID	1024006
Device MAC address	24
Object Type	AI
Instance Number	4
Engineering Units	kW
Network Variable?	True
Server Device	1024006
Client Devices	1028006
Included with Functional	
*Represents information that shall reside in the relevant property for the object	

C. Point Naming Convention:

1. The University shall designate the ‘Building’ descriptor. The ‘Equipment Type’ descriptor shall define the equipment category; e.g., Chiller, Air Handling Unit, or other equipment. The ‘Equipment Code’ descriptor shall define the hardware or software type or function associated with the equipment; e.g., supply temperature, water pressure, alarm, mixed air temperature setpoint, etc. and shall contain any numbering conventions for multiples of equipment; e.g., CHLR1KW, CHLR2KW, BLR2AL (Boiler 2 Alarm), HWP1ST (Hot Water Pump 1 Status).

2. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across Owner’s WAN. Inter-facility consistency shall be maintained to ensure transparent operability to the greatest degree possible.

D. Device Addressing Convention:

1. BACnet network numbers and Device Object IDs shall be unique throughout the network.

2. All assignment of network numbers and Device Object IDs shall be coordinated with The University.

3. The Contractor shall coordinate with The University or a designated representative to ensure that no duplicate Device Object IDs occur.

4. Alternative Device ID schemes or cross Project Device ID duplication if allowed shall be approved before Project commencement by The University.

2.14 OPERATOR INTERFACE GRAPHIC SOFTWARE

A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above. The intent of this Specification is to require a graphic package that provides for intuitive operation of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.

B. Graphic software shall support multiple simultaneous screens to be displayed and resizable in a ‘Windows’-like environment. All functions excepting text entry functions shall be executable with a mouse.

C. Graphic software shall provide for multitasking such that third-party programs can be used while the OWS software is on line. Software shall provide the ability to alarm graphically even when operator is in another software package.

D. Operating system software shall be Microsoft Windows (current version used by UTHSCSA FM Utilities).

E. The software shall allow for Owner creation of user-defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics. These graphics shall be capable of displaying all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse

F. Screen Penetration: The operator interface shall allow users to access the various system graphic screens via a graphical penetration scheme by using the mouse to select from menus or ‘button’ icons. Each graphic screen shall be capable of having a unique list of other graphic screens that are directly linked through the selection of a menu item or button icon.

G. Dynamic Data Displays: Dynamic physical point values shall automatically updated at a minimum frequency of six (6) updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.

H. Point Override Feature: Each displayed point shall be individually enabled/disabled to allow mouse-driven override of digital points or changing of analog points. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator’s user name. A list of points that are currently in an override state shall be available through menu selection.

I. Submit all Graphics per Section 25 00 00.

J. Dynamic Symbols: Provide a selection of standard symbols that change in appearance based on the value of an associated point.

   1. Analog symbol: Provide a symbol that represents the value of an analog point as the length of a line or linear bar.

2. Digital symbol: Provide symbols such as switches, pilot lights, rotating fan wheels, etc. to represent the value of digital input and output points.

3. Point Status Color: Graphic presentations shall indicate different colors for different point statuses. (For instance, green = normal, red = alarm, gray (or '???') for non-response.

K. Graphics Development Package: Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

1. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.

2. The Graphic Development Package shall use a mouse or similar pointing device to allow the user to perform the following:

   a. Define symbols.

   b. Position items on graphic screens.

   c. Attach physical or virtual points to a graphic.

   d. Define background screens.

   e. Define connecting lines and curves.

   f. Locate, orient and size descriptive text.

   g. Define and display colors for all elements.

   h. Establish correlation between symbols or text and associated system points or other displays.

   i. Create hot spots or link triggers to other graphic displays or other functions in the software.

2.15 REMOTE PERSONAL COMPUTER WORKSTATION GRAPHIC SOFTWARE

A. Remote graphic operator software shall provide all the functionality specified for the local graphic software. It shall also provide for communications using the specified modems to connect to the Local Supervisory or Primary LAN, and using the Internet. Coordinate requirements with UTHSCSA FM Utilities department.

B. Software shall not require graphic images to be sent across the phone lines or 56Kbps or slower Internet connection. Graphic images shall reside on the remote operator workstation hard drive and all licenses must be provided for the graphic software on the remote machine. Exceptions to this requirement include:

1. System configuration uses an Internet server and presents web pages that can be pulled up using a standard browser.

2. System configuration uses an Internet server and presents the standalone application running locally but controlled via a remote browser. Operator Interface Graphical Software application must therefore support multi-instancing to allow multiple simultaneous remote connections and use of the graphic software.

C. Software shall be capable of initiating communication to the any LAN, upon user command, to perform all specified functions. Software shall be capable of initiating communication to the LANs in accordance with user-programmed time schedules to upload trend and report data. Software shall be capable of communicating from the LAN in accordance with user-programmed time schedules to report alarms, upload trend, and report data. Software shall automatically terminate the communication whenever all applications requiring modem connection are closed.

PART 3 - EXECUTION

3.01 SYSTEM CONFIGURATION

A. Contractor shall thoroughly and completely configure BAS system software, supplemental software, network communications, CSS, OWS, remote operator workstation, portable operators terminal, printer, and remote communications.

3.02 SITE-SPECIFIC APPLICATION PROGRAMMING

A. Provide all database creation and Site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Provide all initial Site-specific application programming and thoroughly document programming. Generally meet the intent of the written sequence of operation. It is the Contractor’s responsibility to request clarification on sequence issues that require such clarification.

B. All Site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the Warranty Period.

C. All programming, graphics and data files must be maintained in a logical system of directories. All file names shall adhere to the naming convention format as established in The University’s Standard Acronyms documentation. All files developed for the Project will be the property of The University and shall remain on the workstation(s)/server(s) at the completion of the Project.

3.03 PASSWORD SETUP

A. Set up the following password levels to include the specified capabilities:

1. Level 1: (Owner’s BAS Administrator):
   a. Level 2 capabilities.
   b. View, add, change and delete user names, passwords, password levels.
   c. All unrestricted system capabilities including all network management functions.
2. Level 2: (Programmer):
   a. Level 3 capabilities.
   b. Configure system software.
   c. Modify control unit programs.
   d. Modify graphic software.
   e. Essentially unrestricted except for viewing or modifying user names, passwords, password levels.
3. Level 3: (Senior HVAC Technician):

    a. Level 4 capabilities.
    b. Override output points.
    c. Change setpoints.
    d. Change equipment schedules.
    e. Exit BAS software to use third party programs.

B. Contractor shall assist Owner's operators with assigning user names, passwords and password levels.

3.04 POINT PARAMETERS

A. Provide the following minimum programming for each analog input:

1. Name.
2. Address.
3. Scanning frequency or COV threshold.
4. Engineering units.
5. Offset calibration and scaling factor for engineering units.
6. High and low alarm values and alarm differentials for return to normal condition.
7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.
9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.

B. Provide the following minimum programming for each analog output:

1. Name.
2. Address.
3. Output updating frequency.
4. Engineering units.
5. Offset calibration and scaling factor for engineering units.
6. Output Range.
7. Default value to be used when the normal controlling value is not reporting.

C. Provide the following minimum programming for each digital input:

1. Name.

2. Address.
3. Engineering units (on/off, open/closed, freeze/normal, etc.).
4. Debounce time delay.
5. Message and alarm reporting as specified.
6. Reporting of each change of state, and memory storage of the time of the last change of state.
7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

D. Provide the following minimum programming for each digital output:

1. Name.
2. Address.
3. Output updating frequency.
4. Engineering units (on/off, open/closed, freeze/normal, etc.).
5. Direct or Reverse action selection.
6. Minimum on-time.
7. Minimum off-time.
8. Status association with a DI and failure alarming (as applicable).
9. Reporting of each change of state, and memory storage of the time of the last change of state.
10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
11. Default value to be used when the normal controlling value is not reporting.

3.05 TRENDS

A. Contractor shall establish and store trend logs. Trend logs shall be prepared for each physical input and output point, and all dynamic virtual points such as setpoints subject to a reset schedule, intermediate setpoint values for cascaded control loops, and the like as approved by The University.

B. The University will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being stored properly.

1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.

C. Sample times indicated as COV (±) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.

D. Trending intervals or COV thresholds shall be dictated by The University upon system start-up.

E. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before final acceptance of the system.

3.06 TREND GRAPHS

A. Prepare controller and workstation software to display graphical format trends. Trended values and intervals shall be the same as those specified

B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.

C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb., percent open, etc.

D. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.

F. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period.

G. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

[Engineer must edit the following to be Project specific.]

3.07 ALARMS

A. This Section supersedes and over rules all references to building automation alarms in the Contract Documents, including all sequences of operations and other sections of the BAS Specification in regards to alarms. The Contractor shall support and not impede direct negotiations between the BAS Provider and The University to allow the customizing necessary for customizing alarms and alarm parameters to meet The University's needs.

B. The BAS Provider is required to submit a point summary to confirm building automation point names as specified herein The BAS Provider shall submit this point summary with the addition of identifying all alarms which includes detail information on the alarm parameters to the UTHSCSA for approval prior to the beginning of any Commissioning process of the building automation system.

C. UTHSCSA will provide the format form to the BAS Provider upon request. The University shall grant approval of alarms to be verified through Commissioning by issuing the approved alarms to the Contractor. The approved alarms issued to the Contractor shall be used for the Functional Test Procedures alarms tested. The Contractor shall initiate the start of this process immediately after building automation submittal have been approved and monitor the progress to ensure the construction schedule is not delayed.

D. Analog Input Alarms:

1. Duct Static Pressure:

   a. Alarm @ +(-) 0.3 inches from set point for 5 minutes.

   b. Normal @ +(-) 0.2 inches from set point for 5 minutes.

   c. Alarm is active after fan is proven ON for the minimum time necessary to allow the sensor to be within the alarm parameter.

   d. Alarm is deactivated after fan is proven OFF.

2. Duct Air Temperatures:
    a. Alarm @ +(-) 2.0 degrees F from set point for 5 minutes.
    b. Normal @ +(-) 1.0 degrees F from set point for 5 minutes.
    c. Alarm is active after fan is proven ON for the minimum time necessary to allow the sensor to be within the alarm parameter.
    d. Alarm is deactivated after fan is proven OFF.
3. Space or Room Temperature:
    a. Typically will be alarmable with adjustable limits and time delay.
4. Duct or Space Humidity:
    a. Alarm @ (+) 15 percent from set point (60 percent) for 5 minutes.
    b. Alarm @ (-) 20 percent from set point (60 percent) for 5 minutes.
    c. Normal @ 5 percent from offset alarm parameters for 5 minutes.
    d. Point is always ready to alarm.
5. Water temperature sensors which are inputs to control loops:
    a. Submit reasonable alarm parameter to prevent nuisance alarming.
    b. Owner will confirm alarm.
6. All other Analog Inputs:
    a. BAS Provider shall utilize their expertise and recommend not less than three (3) analog input alarms which protect The University’s best interests.
    b. Identify recommended alarms in submittal.
    c. Owner will confirm alarm.

E. Digital Inputs Alarms:
1. Proofs (current sensor, air flow switches, water differential pressure switches etc.).
    a. Digital inputs paired with BAS digital output will have the ability to alarm at all times.
    b. Alarm will delay for the reason time needed when the state of the digital output changes to prevent nuisance alarms.
    c. Point is in alarmed condition when the value of the digital input does not equal the value of the digital output after the time delay.
    d. Point is in the Normal condition when the value of the digital input equals the value of the digital output after the time delay.
    e. Digital input proofs without a paired digital output shall not alarm and be for monitoring purposes only.
2. Safeties (high static cutout, freeze condition, excessive vibration, high humidity cutout, VFD fault, etc.).

a. The digital input shall be always ready to alarm without delay.

b. The digital input shall display “ALARM” at the Alarm screen when activated.

c. The digital input shall display “NORMAL” at the Alarm screen when deactivated.

3. Monitoring Digital Inputs (auxiliary drain pan alarm, Liebert Unit general alarm, water detector, etc.) the exception is air filter differential pressure switch.

    a. All digital inputs which “deactivated” is the normal state of planed operations shall alarm when the normal state of planed operation changes.

    b. The digital input shall display “ALARM” at the Alarm screen when activated.

    c. The digital input shall display “NORMAL” at the Alarm screen when deactivated.

4. Air Filters:

    a. Typically will not be alarmable.

    b. Submit as not alarmable and Owner will confirm.

    c. The digital input shall display “DIRTY” when activated.

    d. The digital input shall display “CLEAN” when deactivated

F. Analog Outputs Alarms:

1. All Analog Outputs:

    a. BAS Provider shall utilize their expertise and recommend any analog output alarms which protect The University’s best interests.

    b. Identify recommended alarms in submittal.

    c. Owner will confirm any alarms.

G. Digital Outputs Alarms:

1. Refer to digital inputs paired with digital outputs as specified herein.

2. All Digital Outputs:

    a. BAS Provider shall utilize their expertise and recommend any digital output alarms which protect The University’s best interests.

    b. Identify recommended alarms in submittal.

    c. Owner will confirm any alarms.

H. Nuisance Alarms: All alarms which have been identified by The University as a nuisance alarm due to numerous times in and out of alarm, shall be addressed and corrected by the Contractor in a manner that The University has approved.

I. See requirements for additional equipment-specific alarms specified in the Contract Documents.

3.08 GRAPHIC SCREENS

[Engineer must provide electronic control design floor plans.]

A. Floor Plan Screens: The Contract Document Drawings will be made available to the Contractor in AutoCAD (current version used by UTHSCSA FM Drafting department) format upon request. These Drawings may be used only for developing backgrounds for specified graphic screens; however The University does not guarantee the suitability of these Drawings for the Contractor's purpose. Graphic Screens shall be submitted for approval.

1. Provide graphic floor plan screens for each floor [wing] [tower] [other] of each building.

    a. Indicate the location of all equipment that is not located on the equipment room screens.

    b. Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens.

    c. Display the space temperature point adjacent to each temperature sensor symbol. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct colors to demarcate each air handling unit zone.

    d. Mechanical floor plan Drawings will be made available to the Contractor upon request for the purpose of determining zone boundaries. Indicate room numbers as provided by The University.

    e. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding equipment schematic graphic screen.

2. Provide graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.

3. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.

4. Provide a graphic Site plan with links to and from each building plan.

B. System Schematic Screens: Provide graphic system schematic screen for each HVAC subsystem controlled with each I/O point in the Project appearing on at least one graphic screen. System graphics shall include flow diagrams with status, setpoints, current analog input and output values, operator commands, etc. as applicable. General layout of the system shall be schematically correct. Input/output devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen.

1. Provide graphic screens for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupied, unoccupied, warm-up, cool-down). Link screens for air handlers to the heating system and cooling system graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.

2. Provide a graphic screen for each zone. Provide links to graphic system schematic screens of air handling units that serve the corresponding zone.

3. Provide a cooling system graphic screen showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link screens for chilled water and condenser water systems if they cannot fit onto one cooling plant graphic screen.

4. Link screens for heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.

C. Bar Chart Screens: On each graphic Bar Chart Screen, provide drawing links to the graphic air handling unit schematic screens.

1. Provide a graphic chilled water valve screen showing the analog output signal of all chilled water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and setpoint of each air handling unit, cooling system chilled water supply and return temperatures and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant screen and this graphic screen.

2. Provide a graphic heating water valve screen showing the analog output signal of all air handling unit heating water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated setpoint and the outside air temperature and humidity.

D. Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a ‘high alarm’ condition in a red color, ‘low alarm’ condition in a blue color. Indicate digital values that are in alarm condition in a red color.

END OF SECTION 25 55 00 00e

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SECTION 25 55 00 00f - BAS COMMUNICATION DEVICES (RETROFIT)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Section includes:

1. Local Supervisory LAN Gateways/Routers.
2. Chiller Controls Interface Device (CID).
3. Variable Frequency Drives (VFD’s).

B. Provide all interface devices and software to provide an integrated system connecting BCs, AACs, ASCs and Gateways to The University’s Wide Area Network (WAN).

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 LOCAL SUPERVISORY LAN GATEWAYS/ROUTERS

A. The Supervisory Gateway shall be a microprocessor-based communications device that acts as a gateway/router between the Supervisory LAN CSSs or OWS and the Primary LAN.

B. The Gateway shall perform information translation between the Primary LAN and the Local Supervisory LAN, which is 100 Mbps Ethernet TCP/IP and shall use BACnet over IP.

C. The gateway shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 25 14 10. Each gateway/router shall be mounted in a lockable enclosure unless it is a PC that also serves as an OWS.

D. The gateway/router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the following functions from the CSS, OWSs, and POTs:

1. Configure systems.
2. Monitor and supervise control of all points.
3. Change control setpoints.
4. Override input values.
5. Override output values.
6. Enter programmed start/stop time schedules.
7. View and acknowledge alarms and messages.
8. Receive, store and display trend logs and management reports.
9. Upload/Download programs, databases, etc. as specified.

E. Upon loss of power to the Gateway, the battery shall provide for minimum 100 hour backup of all programs and data in RAM.

F. The Gateway shall be transparent to control functions and shall not be required to control information routing on the Primary LAN

2.03 CHILLER CONTROLS INTERFACE DEVICE (CID)

A. The CID shall be a microprocessor-based communications device that acts as a gateway between the control protocol and the applicable chiller controller.

B. The CID shall contain its own microprocessor, RAM, battery, communication ports and, power supply.

C. Each CID shall support full bi-directional communications translation as more fully specified in Section 25 15 10.

D. The following points shall be mapped as a minimum:

1. CHW Supply and Return Temperatures.
2. CW Supply and Return Temperatures.
3. Power Consumption (kW).
4. Percent of Power Consumption (compared to maximum).
5. Bearing Temperature.
6. Suction and Head Pressures.
7. Suction and Head Temperatures.
8. All available alarms; common alarm as minimum.
9. Chiller Status.
10. Enable/Disable.
11. Current Limit Percent.
12. CHW Setpoint and Setpoint Reset.

13. Current Amperage.

2.04 VARIABLE FREQUENCY DRIVE INTERFACE

1. Enable / Disable.
2. Drive Speed in HZ.
3. Drive current.
4. Drive Alarms.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Provide all interface devices and software to provide an integrated system.

D. Closely coordinate with The University, or designated representative, to establish IP addresses and communications to assure proper operation of the building automation system with Owner’s WAN.

END OF SECTION 25 55 00 00f

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SECTION 26 00 00 00 - ELECTRICAL DEMOLITION

PART 1 -- GENERAL

1.01 WORK INCLUDED

A. Electrical demolition for remodeling.

B. Electrical/control portion of HVAC work covered by Division 23 pertaining electrical demolition shall follow the requirement set forth by this and related electrical specifications.

1.02 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for minor electrical demolition for remodeling.

1. Section 26 00 00.UT - Basic Electrical Requirements. Hereafter all UT Spec Sections refer to UT Specs found at https://apps.utsystem.edu/engineeringspecs/Download2.aspx

B. In the event of conflict regarding minor electrical demolition requirements between this Section and any other Section, the provisions of this Section shall govern.

PART 2 -- PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: as specified in individual Sections.

B. Provide all materials necessary for work.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. All demolitions or modifications to existing systems shall be coordinated through UTHSCSA's Representative. Demolition drawings are based on casual field observation and existing record documentations. Therefore the accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements and circuiting arrangements are as shown on Drawings and abandoned wiring and equipment serve only abandoned facilities. The Contractor shall be responsible for reporting discrepancies to Engineer before disturbing existing installation.

B. Beginning of demolition means Contractor accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal. Provide temporary wiring and connections to maintain remaining systems in service during demolition and/or modification; to include lock out tag out (LOTO) and make safe the electrical systems during demolition. UTHSCSA reserves the right up to 24 hours prior to any scheduled event to delay or suspend shutdowns or outages to more convenient times at no additional cost.

B. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. No work shall begin without proper permits and authorizations. Disable system only to make switchovers and connections. Obtain permission from UTHSCSA at least three (3) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

C. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify UTHSCSA at least three (3) weeks before partially or completely disabling system. Minimize outage duration. Provisions for manual fire watch shall be provided in areas where services are interrupted. Make temporary connections to maintain service in areas adjacent to work area.

D. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Notify UTHSCSA at least three (3) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new plan drawings.

B. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes full length from source to device. Cut embedded or concealed conduit flush with walls and floors, and patch surfaces to match.

1. Where source and device span an area outside the scope of work, coordinate with design engineer for scope of work pertaining to removing existing raceways. If existing raceways are permitted to remain, cap conduit at minimum 36” into an accessible location within the scope of work. Provide pull string for future use and label conduit ”SPARE-XXX-YYY” where “XXX” is the source equipment identifier and “YYY” is the room description and/or location of the source equipment

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlet boxes that are not removed.

D. Disconnect and remove abandoned panelboards and distribution equipment.

E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

G. Repair adjacent construction and finishes damaged during demolition and extension work.

H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

I. Extend existing installations using materials and methods compatible with existing electrical installation or as specified.

J. The level of completion shall be demonstrated to UTHSCSA’s Representative.

K. Where equipment is indicated to be demolished and returned to UTHSCSA, the Contractor shall include the delivery of this equipment to UTHSCSA's site storage area. Remove with care all equipment to be relocated. Repair or replacement of newly damaged equipment is the responsibility of the Contractor.

L. Where devices, luminaires, equipment and other associated electrical work are existing and scheduled to remain, the Contractor shall protect the systems for the duration of the project. Any damage sustained to the existing elements during construction are the sole responsibility of the Contractor.

M. Clearly identify any existing shared neutrals that are scheduled to remain and that are associated with branch circuits included in the scope of work. Report the findings to design engineer for review.

3.04 CLEANING AND REPAIR

A. The Contractor shall follow UTHSCSA’s clean work policy and shall include the removal of trash and demolished material from the building or work area at the end of each day and removal from the site once a week.

B. The Contractor shall be responsible for repairing adjacent construction and finishes damaged during demolition and/or modification. The Contractor shall be responsible for the removal of ceiling tiles required in the demolition work. The Contractor shall be responsible for the replacement of damaged tiles and reinstallation of the ceiling prior to final acceptance.

C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement to UTHSCSA.

D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.

3.05 DISPOSITION OF MATERIAL AND EQUIPMENT

A. Review with UTHSCSA materials that have been removed and are no longer required, to determine any which UTHSCSA may desire to keep. Deliver those materials that UTHSCSA desires to UTHSCSA's specified location.

B. For those materials not required by UTHSCSA, dispose of them in accordance with applicable regulations.

C. When removing light fixtures the following requirements shall be followed. Bulbs: Fluorescent light bulbs that contain mercury must be handled carefully so that they don't break, packaged in approved boxes furnished by UTHSCSA, and given to UTHSCSA for disposal. Ballasts: Fluorescent lamp ballasts shall be treated as PCB waste unless labeled "no PCBs." PCB waste is regulated and must be packaged in drums furnished by UTHSCSA, and given to UTHSCSA for disposal. Fixtures: Fixtures and ballasts labeled "no-PCBs" will be disposed of by contractor in accordance with any applicable regulations.

END OF SECTION 26 00 00 0000 00

Task	Specification	Specification Description
26 01 00 00	26 00 00 00	Electrical Demolition
26 01 20 00	26 00 00 00	Electrical Demolition
26 01 50 00	26 00 00 00	Electrical Demolition
26 01 50 51	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 51	26 00 00 00	Electrical Demolition
26 01 50 52	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 53	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 53	26 00 00 00	Electrical Demolition

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SECTION 26 05 00 00 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Hinged cover enclosures and cabinets

B. Contactors

C. Control relays

D. Push buttons, and selector switches

E. Terminal blocks and accessories

F. Penetration sealing systems (fire stops)

G. Electrical/control portion of HVAC work covered by Division 23 pertaining basic electrical materials and methods shall follow the requirement set forth by this and related electrical specifications.

1.02 1.02 APPLICABLE CODES AND STANDARDS

A. NFPA 70, National Electrical Code (latest edition)

B. IEEE C2, National Electrical Safety Code, (latest edition)

C. Applicable publications of NEMA, ANSI, IEEE, and ICEA

D. Underwriters Laboratories, Inc. Standards (UL)

E. Federal, city, state, and local codes and regulations having jurisdiction

F. OSHA requirements

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

H. NEMA WD 1 – General-Purpose Wiring Devices

I. UL 98 - Enclosed Switches

1.03 INTENT

A. This Section is not, and shall not be interpreted to be, a complete listing of all materials or equipment that is Contractor furnished and erected. It is intended to clarify and further define the Contractor scope of work, procurement, and responsibilities for those incidental materials that are not specified by other specifications, but important to a complete and operational system.

B. The Contractor shall furnish all equipment and materials, whether or not specified in other Sections of specification and on drawings, for installation and connection required to place equipment into satisfactory operating service. The Contractor shall review the Drawings and specifications for clarification of his responsibility in the handling and installation of equipment and material. Where applicable, and not in contradiction with the Drawings and specifications, the Contractor shall install and connect the equipment in accordance with the manufacturer's recommendations and instructions.

C. All materials and equipment shall be of types and manufacturer specified. Should materials or equipment so specified be unattainable, the Contractor shall submit the description and manufacturer's literature, reason for substitution request and shall secure the approval of the Engineer before substitution of other material or equipment is purchased. This Section establishes performance requirements and the quality of equipment acceptable for use.

1.04 SUBMITTALS

A. Provide submittals in addition and in accordance with Section 26 00 00.UT, Basic Electrical Requirements, and Division 01 UT.

B. Submit manufacturer's literature and specification data sheets for each type of basic material, which is applicable to the project.

C. Record Documents: In addition to hard copy format, all material submitted as final record products, including approved Shop Drawings and submittals, shall be submitted to the Owner in its original electronic file format on compact disc or DVD. Material may be scanned into electronic file format where necessary.

1.05 DELIVERY, STORAGE AND HANDLING

A. All equipment and materials shall be delivered to the Project Site clean and sealed for protection.

B. Moisture: During construction, protect switchgear, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately upon receiving the products and maintain continually.

C. Damage: Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

D. Finish: Protect factory finish from damage during construction operations until acceptance of the Project. Restore any finishes that become stained or damaged to Owner's satisfaction.

PART 2 - PRODUCTS

2.01 ENCLOSURES AND CABINETS

A. Enclosures and cabinets for all Contractor furnished electrical equipment and devices shall be suitable for the location and environmental conditions and shall be of the NEMA type as shown in Table 26 05 00 00-1. Exceptions shall be specifically designated on the Drawings.

Table 26 05 00 00-1

Enclosures

Location	Environment	Enclosure Type
Indoor Utility	Dry, subject to dust, falling dirt and dripping non-corrosive liquids	NEMA 12
Indoor	Clean, Dry	NEMA 1
Outdoor	Subject to windblown dust and rain, splashing water, and hose-directed water	NEMA 4
Indoor	Wet, subject to hose-directed water	NEMA 4
Outdoor	Subject to falling rain, sleet, and external ice formation	NEMA 3R
Indoor or Outdoor	Subject to corrosion, windblown dust and rain, splashing water and hose-directed water	NEMA 4X

B. Enclosures shall have the following properties:

1. Hinged Cover Enclosures: NEMA 250.
   - a. Type 1: Steel.
   - b. Type 4: Steel with gasket door, rain tight.
   - c. Type 4X: Stainless steel, (polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas).
   - d. Type 12: Steel with gasketed door, dust-tight.

C. Finish: Exterior, manufacturer's standard gray enamel finish; interior, white enamel finish.

D. Covers: Continuous hinge, held closed by flush latch operable by hasp and staple for padlock. Where required for NEMA ratings, gaskets shall be neoprene rubber.

E. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14-gauge steel, white enamel finish.

F. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

G. Forced Ventilation: Where indicated, provide 115V single-phase fan motor, filtered with air plenum, finger guard, and stainless steel grille. Washable aluminum filter, accessible for cleaning from outside the enclosure; 20,000-hour continuous operation without lubrication or service. Provide matching exhaust grille assembly. Mount fan in lower side corner, exhaust grille in opposite upper side corner.

2.02 CONTACTORS

A. Acceptable Manufacturers

1. General Electric Company
2. Square D Company
3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. Contactors: NEMA ICS 2; electrically held or mechanically held as indicated on Drawings. Two-wire control for electrically held contactors and three-wire control for mechanically held contactors.

C. Enclosure: NEMA 1 unless indicated otherwise on Drawings.

D. Control Transformer: Provide when indicated on Drawings. Minimum capacity shall be 100 VA. Provide two primary and one secondary fuse protection.

E. Coil operating voltage; 110 volts, 60 Hz or as per drawings.

F. Size: NEMA ICS 2; size as indicated on Drawings.

G. Contacts: As indicated on Drawings; 600 Volts, 60 Hz.

H. Provide solderless pressure wire terminals on bus terminals suitable for mounting in panelboard as indicated on Drawings.

2.03 CONTROL RELAYS

A. Acceptable Manufacturers

1. General Electric
2. Cutler-Hammer
3. Square D Company
4. Allen-Bradley
5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. Provide magnetic control relays, NEMA Class A: A300 (300 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts, and meeting the requirements of NEMA ICS 2.

C. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a solid-state timer attachment adjustable from 0.2 to 60 seconds (minimum) or with range as indicated. Provide with field convertible from ON delay to OFF delay and vice versa.

D. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

2.04 PUSH BUTTONS, AND SELECTOR SWITCHES

A. Acceptable Manufacturers

1. Allen-Bradley
2. Square D
3. Cutler Hammer
4. Seimens
5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. For non-hazardous, indoor, dry locations, including control panels, and individual stations, provide heavy duty, NEMA 13, oil tight type pushbuttons, indicating lights, selector switches, and stations for these devices.

C. For nonhazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, NEMA 4, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4 watertight enclosures. Provide special gasketing required to make complete station watertight.

D. For hazardous locations, provide control station listed by UL for Class I, Divisions 01 and 02, Groups C and D; Class II, Division 01 and 02, Groups E, F, and G. Specific type shall be in accordance with area classification as indicated on the Drawings.

E. For corrosive locations, provide nonmetallic components and enclosures meeting NEMA Type 4X.

F. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide push-button stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Nameplates shall be as specified in Section 16195.

G. Utilize selector switches having standard operating levers. All indicating lights shall be LED type, push-to-test type. Provide ON or RUN lights colored black. Provide OFF or STOP lights colored red.

2.05 TERMINAL BLOCKS AND ACCESSORIES

A. Signal And Control Terminals

1. Acceptable Manufacturers
   a. Phoenix Contact
   b. TE Connectivity
   c. Weidmüller
   d. Entrelec
   e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements substitution requirement.
2. Signal and Control Terminals: Modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts. Minimum terminal width of 0.24-inch, capable of holding two No. 12 or two No. 14 AWG conductors in each connector. Terminal identification numbers shall be thermoset characters (black) on a white background. Provide 25 percent spare terminals.

B. Power Terminals

1. Acceptable Manufacturers
   a. Buchanan

   b. Ilsco

   c. Square D Company

   d. Burndy

   e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

2. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts, size as required. Provide 25 percent spare terminals. **All terminals shall be copper, AL/CU are not acceptable.**

2.06 PENETRATION SEALING SYSTEMS (FIRE STOPS)

A. Provide penetration sealing where conduit, cable tray, etc. pass through rated walls, ceilings, and floors. See Section 07 84 00, Fire Stopping, for sealing requirements and systems.

2.07 UL LISTING

A. All equipment and materials shall be new and conform to the requirements of this Section. All equipment and materials shall be UL listed, and shall bear their label whenever standards have been established and level service is regularly furnished. All equipment and materials shall be of the best grade of their respective kind for the purpose. Determination of the grade shall be by the engineer.

PART 3 -EXECUTION

3.01 FABRICATION - CONTROL ENCLOSURES AND CABINETS

A. Shop assembles enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

3.02 INSTALLATION - ENCLOSURES AND CABINETS

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.

B. Provide accessory feet for freestanding equipment enclosures.

C. Install trim plumb.

3.03 ERECTION OF EQUIPMENT

A. Manufacturer's Installation Instructions: Where furnished or called for by the manufacturer equipment manufacturer's installation instructions shall be considered a part of this specification and fully complied with. Where the Contractor damages the finishing coat of paint in existing or completed areas, he shall refinish with matching paint.

B. Mounting Heights: Individual safety switches and buttons and devices shall normally be installed at the following mounting heights, when not specified on the Drawings.

1. Safety Switches: 6 feet 0 inches (to top).

2. Pushbuttons: 4 feet 0 inches (to center).

3. Control Panels: 6 feet 0 inches (to top).

C. Mounting: Equipment and control devices shall be supported independent of conduit connections. Panels or cabinets shall be mounted on metal frame supports independently of equipment. Control devices and metal enclosures shall be bolted or welded to steel channel or steel plate. All electrical equipment and devices not covered by the above, such as miscellaneous switches, thermostats, duct switches, temperature switches, floats, photoelectrical devices, and similar electrical devices shall be located and set as suitable for the application. Where control panels are provided as part of the equipment racks mounted on the floor, they shall be provided to support conduits and flexible connections to control panels.

3.04 COORDINATION

A. Exact location of all electrical equipment, devices and fixtures shall be determined in field by contractor and verified by Engineer's field representative prior to installation.

B. Contractor responsible for coordinating work across all trades.

C. Information represented in electronic files is representative and diagrammatic in nature. Contractor is responsible for coordinating all trades and for maintaining up to date electronic files for coordination and record keeping purposes.

3.05 Warranty

A. At minimum, the equipment and devices shall be warranted according to UTHSCSA's General Conditions agreement. Additional manufacturer's standard warranties shall not be negated.

END OF SECTION 26 05 00 00

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Task	Specification	Specification Description
26 05 00 00	26 00 00 00	Electrical Demolition

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SECTION 26 05 19 00 - CABLE, WIRE, AND CONNECTORS, 600 VOLT

PART 1 GENERAL

1.01 WORK INCLUDED

A. Building wire.

   1. Power distribution circuitry.
   2. Control system circuitry. (including HVAC, Div. 23)
   3. Lighting circuitry.
   4. Appliance and equipment circuitry.
   5. Motor-branch circuitry.
   6. Outdoors lighting and power.
   7. Other systems using electrical power.

B. Cable.

C. Wiring connections and terminations.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining 600 volt cable, wire and connectors shall follow the requirement set forth by this specification.

1.02 REFERENCES

A. NEMA WC 3 - Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

B. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

C. ANSI/UL 83 – Thermoplastic-Insulated Wire and Cables

D. NFPA 70 – National Electrical Code, latest edition

E. NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

F. Where application of National Electrical Code, trade association standards or publications appears to be in conflict with the requirements of this Section, the Architect/Engineer shall be asked for an interpretation.

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to General Conditions for submittal requirement.

B. Submit manufacturer's literature and specification data sheets for each item of cable, wire connectors, or product marked by line item.

C. Qualification of cable and wire manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years experience.

D. Where application of National Electrical Code, trade association standards or publications appear to be in conflict with the requirements of this Section, an RFI shall be submitted.

1.04 DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire or connectors shall be removed from project site.

B. Store cable, wire and connectors in a clean, dry indoor space in their factory-furnished coverings, which provides protection against the weather.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Cable, wire and connectors shall be of manufacturer's standard materials, as indicated by published product information.

B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 AWG copper with insulation as noted below. Minimum size for control shall be #14 AWG copper.

C. The conductors of wires and cables shall be of copper (tinned where specified), and have conductivity in accordance with the standardization rules of the IEEE. The conductor and each strand shall be round and free of kinks and defects.

D. All 600V power wiring shall be colored according to Section 26 05 53 Electrical Identification.

E. All cable specified for use in tray shall be multiconductor and shall have an outer jacket of flame-retardant, moisture and sunlight resistant polyvinyl chloride (PVC) and shall be UL and NEC approved type for tray installation. Cable installed in cable tray outdoors shall have a jacket that is UV resistant chlorinated polyethylene (CPE) or polyvinyl chloride (PVC), rated 90°C per UL Standard 1277.

F. All low voltage power and control cable installed in open cable tray above ceilings used for return air shall be plenum rated. Where tray cable is not available in size and type required, conductors shall be installed in conduit.

G. Use copper lugs.

2.02 BUILDING WIRE

A. Thermoplastic-insulated Building Wire: NEMA WC 5.

B. Rubber-insulated Building Wire: NEMA WC 3.

C. Feeders and Branch Circuits Larger Than 10 AWG: 98% conductivity copper, soft-drawn, stranded conductor, 600 volt insulation, THHN/THWN-2. Use XHHW conductors where installed in conduit underground.

D. Feeders and Branch Circuits 10 AWG and Smaller: 98% conductivity copper, soft-drawn, solid conductor, 600-volt insulation, THHN/THWN-2.

E. MC Cable: MC cable may be used in branch circuits from junction boxes to loads. MC cable, where used shall be UL listed, rated for 600 volts and installed per the National Electrical Code. Conductors shall be annealed copper, insulated with high heat moisture resistant and lead free PVC. Conductors shall be jacketed with abrasion, moisture, gasoline and oil resistant nylon or UL listed equivalent. Conductors shall be wrapped with polypropylene tape and covered with interlocking aluminum armor. MC cable shall be supported at intervals not exceeding 6 feet unless otherwise permitted by the NEC. Bends in MC cable shall be made such that the cable shall be made such that the cable will not be damaged and the radius of the inner edge is not less than seven times the cable diameter. Conductors shall be color coded per specification section 26 05 53.

2.03 REMOTE CONTROL AND SIGNAL CABLE

A. 600 Volt Insulation Control Cable for Class 1 Remote Control and Signal Circuits, Type TC:

   1. Individual Conductors: 14 AWG, stranded copper, XHHW insulation. Rated 90 degrees C dry, 75 degrees C wet, color-coded per ICEA Method 1 plus one green equipment grounding conductor.

   2. Assembly: Bundle wrapped with cable tape and covered with an overall PVC jacket. Cable shall pass IEEE-1202 vertical tray ribbon-burner flame test (210,000 BTU) VW-1.

B. Instrumentation Cable

   1. 300 Volt Instrumentation Cable, Multiple Pairs, Overall Shield, Type PLTC:

a. Individual Conductors: 18 AWG, stranded, tinned copper, flame retardant polyethylene or PVC insulated, rated 105 degrees C, black and white numerically printed and coded pairs.

b. Assembly: Individual twisted pairs having a 100 percent coverage aluminum-polyester shield and 20 AWG stranded tinned copper drain wire. Conductor bundle shall be shielded with 100 percent coverage overall aluminum-polyester shield complete with 20 AWG drain wire. All group shields completely isolated from each other. Bundle wrapped with cable tape and covered with an overall flame retardant PVC jacket. Cable shall pass IEEE-383 vertical tray flame test (70,000 BTU) UL1581.

C. Life Safety Systems Cable

1. All life safety system wiring shall be installed in dedicated conduit or raceway with adequate separation/shielding from all other systems.

2. Life safety systems wiring shall be as specified in the Section 28 31 20 UT– Zoned Fire Alarm and Smoke Detection Systems.

D. Security/Access Control/CCTV Cable

1. All security/access control wiring shall be installed in dedicated conduits.

2. Security/access control wiring shall be rated and as specified on drawings:

2.04 WIRING CONNECTIONS AND TERMINATIONS

A. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements with NEC standards, and proper craftsmanship. Select from only following types, classes, kinds and styles.

1. Type:

a. Solderless pressure connectors

b. Crimp.

c. Threaded.

d. Insulated spring wire connectors with plastic caps for 10 AWG and smaller.

2. Class: Insulated.

3. Material: Copper (for CU to CU connection). No CU/AL connectors/terminals shall be allowed.

4. Style:

a. Insulated terminals. Use ring-terminal for control wiring. Use flange (fork) spade compression terminal for termination of stranded conductors at wiring devices, including ground connection.

b. Split bolt-parallel connector.

c. Pigtail connector.

d. Pre-insulated multi-tap connector.

PART 3 EXECUTION

3.01 INSPECTION

A. Installer must examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 GENERAL WIRING METHODS

A. Install electrical cable, wire and connectors as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and as required to ensure that products serve the intended functions.

B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface. Do not install the conductors until raceway system is complete and properly cleaned.

C. Cables shall be selected on the basis of their purpose and UL listing. Generally, use Type THHN in building interiors and other dry locations. Outdoors and underground in raceways, use Type RHW. Conductors subject to abrasion, such as in lighting poles, shall be Type or THHN.

D. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 75' in length (150' for 277 volt) no conductor smaller than a No. 10 wire shall be used. The sizing of all wire except remote control wire shall be accomplished in the case of both feeder and branch circuits by conforming to the following provisions. Separate neutral conductors shall be provided for each phase of the same size for 120V/277V single-phase application for heavy electrical loads, computer loads, loads fed from isolated transformers, lab equipment, clinic equipment, dedicated circuits, unless noted otherwise on drawings. Voltage drop on feeders and branch circuits shall not exceed 2 percent.

E. Remote control wires shall be no smaller than No. 14 conductors. Control wires shall be run in separate conduits. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code requires the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of The University's duly authorized representative.

F. Install exposed wire and cable, parallel and perpendicular to surface or exposed structural members and follow the surface contours, where possible.

G. Splice branch circuits only in accessible junction or outlet boxes. Control cable shall never be spliced except the final connection to field devices. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings.

H. Wiring Within An Enclosure: Contractor shall bundle ac and dc wiring separately within an enclosure. The Contractor shall utilize panel wire-ways when they are provided. Where wireways are not provided the Contractor shall neatly tag, bundle wires and secure to sub-panel at a minimum of every three inches with T&B Type TC5355 heavy duty mounting bases.

I. Do not band any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors.

3.03 WIRING INSTALLATION IN RACEWAYS

A. Wire and cable shall be pulled into clean dry conduit. Do not exceed manufacturer’s recommended values for maximum pulling tension.

B. Pull conductors together where more than one is being installed in a raceway.

C. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.

D. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.

E. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

F. Place no more than 3 phases, ground, and neutral of a circuit in same raceway. Larger conductor counts shall be approved by engineer.

1. Contractor can combine circuits in a common conduit as long as derating of the conductors' ampacity and other NEC factors are accounted for. The dedicated neutral conductor must be included as a current carrying conductor for all dedicated single-phasecircuits.

G. Provide separate conduit or raceway for line and load conductors of motor starters, safety disconnect switches, and similar devices. Those devices shall not share the same raceway.

H. All conduits shall contain a green grounding conductor. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.

I. Any damage to conductor's outer PVC jacket shall be reason to replace conductor.

3.04 CABLE INSTALLATION

1. Cables shall be supported every 5 feet by J-hooks or other method specified on the drawings. Support shall be from overhead building structures above all other systems and equipment no surface mounted to structure. Cables shall not be supported by other system supports, lay on to of ducts, boxes, conduits or ceiling tiles. Cable may drop to equipment served in area of equipment.

A. Provide protection for exposed cables where subject to damage during construction. Do not install cable before the completion of raceway system.

B. Cable above ceilings shall be in conduit or raceways. Cables, conduits and raceways shall not be laid on ceiling tiles or strapped to ceiling wire.

C. Use suitable cable fittings and connectors.

D. It shall be the Contractor's responsibility to accurately measure all cable runs before the cable is cut. The Contractor shall furnish all tools and equipment, have sufficient properly trained personnel and shall exercise necessary care to ensure that the cable is not damaged during installation. Cable found to be damaged before installation shall not be installed. Cable damage during installation shall be removed and replaced. Repairs to cables can only be done with written permission from The University's Representative and only under special circumstances.

E. Care shall be exercised with cables entering or leaving cable trays that all cable bend radii shall not be less than the recommended minimum and that cables are not left to rest unprotected on any sharp edge or corners.

F. PVC jacketed cable shall not be installed or worked in any way at temperatures below 32 degrees F, unless cable has been previously stored in a heated area 48 hours prior to being pulled and transported to a heated pulling area.

G. Each cable entering an enclosure shall have its conductors bundled together and identified with the cable number. All groups of conductors within an enclosure shall be shaped and formed to provide a neat appearance to facilitate future additions or rework. All control conductors shall be numbered and shall be labeled at each termination with this number, using markers designed for the application.

H. Multi-Conductor Cable Installation: Power and 120V control cable shall be installed in the same tray. When cables leave trays, they shall be protected between the trays and the cable terminal points by drawing them through conduits. Do not route 600V cables (power cable and 120V control cable) in the same conduit or cable tray as low voltage cables (less than 50V, communications, security systems, or control conductors). Do not route security systems, or control cables through communications rooms. Fire alarm cable shall be routed in a separate conduit only.

I. Instrument Cable: Instrument cable shall, when conduit installation is required be installed in rigid steel conduit. They shall not be spliced at any point. The shields and drain wires of shielded signal cables shall be grounded only at one point as indicated on the Drawings.

3.05 WIRING CONNECTIONS AND TERMINATIONS

A. Install splices, taps and terminations, which have equivalent-or-better mechanical strength and insulation as the conductor. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

B. Keep conductor splices and taps accessible and to a minimum, and in junction boxes only. Control circuit conductors shall terminate at terminal blocks only. Splices below grade shall only be in handholes or manholes and shall be made watertight with epoxy resin type splicing kits similar to Scotchcast.

C. Use splice, tap and termination connectors, which are compatible with the conductor material.

D. Thoroughly clean wires before installing lugs and connectors.

E. Terminate spare conductors with electrical tape and label as spare.

F. Power and Lighting Circuits: Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.

G. Use split bolt connectors or pre-insulated connectors for copper wire splices and taps, 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

H. Connections for all wire sizes in motor terminal boxes where the motor leads are furnished with crimped-on lugs shall be made by installing ring type compression terminals on the motor branch circuit ends and then bolting the proper pairs of lugs together. First one layer of No. 33 scotch tape reversed (sticky side out), then a layer of rubber tape, then four layers of No. 33 half-lapped.

I. Identify conductors per Section 26 05 53 –Electrical Identification.

3.06 FIELD QUALITY CONTROL

A. Torque test conductor connections and terminations to manufacturer's recommended values.

B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

C. Conductors in vertical conduits or raceways shall be supported in the manner set forth in the appropriate section of the latest revision of the National Electrical Code. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

D. Conductors may be run in parallel on sizes 1/0 to 500 MCM inclusive provided all paralleled conductors are the same size, length, and type of insulation. Except as otherwise shown on drawings, no more than three conductors may be run in parallel, and they shall be so arranged and terminated as to insure equal division of the total current between all conductors involved. Where parallel connection is contemplated, approval of The University's representative must be obtained before installation is made.

3.07 TESTING AND ACCEPTANCE

A. Before final acceptance, the Contractor shall make voltage, insulation, load tests, and meggar tests, necessary to demonstrate to The University's representative the satisfactory installation and proper performance of all circuits.

B. Test feeder conductors clear of faults. Insulation-resistance test shall be conducted per NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems. Test results below 50 megohms shall be cause for rejection of the wiring installation. Replace and retest all such rejected conductor.

C. At the completion of a project, the Contractor shall provide for The University three (3) complete and finally corrected sets of working drawings, and (1) set of correct CAD and/or Revit files. These sets of working drawings shall be new, unused and in good condition, and shall include the nature, destination, path, size and type of wire and all other characteristics for complete identification of each and every conduit and circuit.

END OF SECTION 26 05 19 0005 19 0005 10 0005 19

Task	Specification	Specification Description
26 05 19 00	26 00 00 00	Electrical Demolition
26 05 19 00	26 05 00 00	Basic Electrical Materials and Methods
26 05 19 13	26 00 00 00	Electrical Demolition
26 05 19 13	26 05 00 00	Basic Electrical Materials and Methods
26 05 19 13	26 05 19 00	Cable, Wire, and Connectors, 600 Volt
26 05 19 16	26 00 00 00	Electrical Demolition
26 05 19 16	26 05 00 00	Basic Electrical Materials and Methods
26 05 19 16	26 05 19 00	Cable, Wire, and Connectors, 600 Volt
26 05 19 23	26 00 00 00	Electrical Demolition
26 05 19 23	26 05 00 00	Basic Electrical Materials and Methods
26 05 19 23	26 05 19 00	Cable, Wire, and Connectors, 600 Volt
26 05 23 00	26 00 00 00	Electrical Demolition
26 05 23 00	26 05 00 00	Basic Electrical Materials and Methods
26 05 23 00	26 05 19 00	Cable, Wire, and Connectors, 600 Volt

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SECTION 26 05 26 00 - GROUNDING

PART 1 -- GENERAL

1.01 WORK INCLUDED

A. Power system grounding.

B. Communication system grounding.

C. Electrical equipment and raceway grounding and bonding.

1.02 RELATED WORK

A. Lightning protection.
B. Transformers
C. Switchgear
D. Ground Buses in Electrical & AV Closets
E. Water Service
F. Building Steel
G. Gas Service
H. Antennas

1.03 REFERENCES

A. NFPA 70 – National Electrical Code, latest edition

B. ANSI/UL 467 – Electrical Grounding and Bonding Equipment

C. ANSI/IEEE STD 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems

D. IEEE 81 – Guide for Measuring Earth Receptivity, Ground Impedance and earth Surface Potential of a ground System

E. IEEE 1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

F. ANSI/TIA/EIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

G. NFPA 780 – Lightning Protection Code.

H. ANSI/NEMA GR 1-2007 – Grounding Rod Electrodes and Grounding Rod Electrode Couplings.

I. ANSI/NETA ATS-2017 – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

1.04 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to grounding electrodes. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operations. Concrete encased electrodes shall be connected as the most effective grounding electrodes. Provide a completely grounded system in accordance with Article 250 of the NEC.

B. Ground each separately-derived system neutral to separate ground buses that are installed in nearest electrical rooms. Transformer, UPS systems, power conditioners, inverters, or other power supplies are separately derived systems. Standby or emergency generators are separately derived systems if the neutral is bonded to the generator frame and if there is no direct connection of the generator neutral conductor to the service neutral conductor.

C. Provide communications system grounding conductor connected to separate electrode (ground bus) that is installed in each IT room.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath, ground bus in electrical rooms and IT rooms, metal frame of the building or structure, ground ring, lightning down lead conductor, grounding conductor in raceways and cables, receptacle ground connectors, and metal underground water pipe.

E. Bonding jumpers shall be installed around non-metal fittings or insulating joints to ensure electrical continuity. Bonding shall be provided where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

F. Supplementary Grounding Electrode: Use driven ground rod on exterior of building or in main service equipment area.

G. Use minimum 6 AWG copper conductors for communications service grounding conductor. Leave 10 feet slack conductor at termination.

1.05 SUBMITTALS

A. Provide submittals in accordance with and in additional to General Conditions for submittal requirement.

PART 2 -- PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Grounding system components shall be as required to comply with the design and construction of the system indicated.

B. Ground conductors shall be stranded tinned, annealed copper cable of the sizes indicated on drawings. Bond grounding conductors at both ends of metallic conduit.

C. Grounding clips shall be Steel City Type G, or equal.

D. Ground Rods shall be copper-encased steel, 1" diameter, minimum length 10 feet.

E. Listing: UL 467.

2.02 Connections:

A.. Materials. Unless otherwise noted, provide exothermic welded type grounding connections for bonds and connections made below grade, embedded in structure, or otherwise concealed. For above grade connections not embedded in structure or otherwise concealed, provide mechanical bolted-type connections utilizing high-conductive copper alloy or bronze lugs or clamps. Where required, provide plated connectors which will not cause electrolytic action between the conductor and the connector.

B. Listing: UL 467.

2.03 CONDUCTORS:

A. Materials. Provide grounding conductors fabricated from annealed copper with conductivity > 98 percent IACS conductivity.
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01. Use solid conductor for No. 12 and No. 10 AWG.

2. Use stranded conductor for No. 8 AWG and larger.

3. Use stranded conductor for applications subject to continuous vibration, such as engine generators and terminations at motors.

4. Use stranded, tinned, annealed copper cable for #2 AWG or larger installed inside the building or structure.

B. Insulation. Where insulated grounding conductors are specified or required, provide green-colored 600-volt rated insulation, type XHHW, THWN, or RHW. Insulation type shall be compatible with associated power and lighting system conductors.

C. Location and Application.

1. Inside building or structure. Provide insulated copper grounding conductors, except where bare copper grounding conductors are indicated on Drawings or specified in this or other Sections.
2. Outside building or structure. Use bare copper grounding conductors, including below-grade building grounding ring (counterpoise).
3. Bonding jumpers. Use bare copper conductor

.D. Listing: UL 834.

2.04 GROUND BUS:

A. Where a field-provided ground bus-bar is required or indicated, provide bus-bar drilled and tapped with double-lug terminations for the quantity of ground connections indicated on the Drawings plus 25% spare capacity, wall-mounted on insulated supports. Use round-edge copper bar with > 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus-bar for not less than 25 percent of the aggregated cross-sectional area of the related feeders. A minimum cross-sectional size of 1/4 inch by 2 inches is required; where ground bus-bar of larger dimensions is indicated on plans or specifications provide the bus-bar with the larger dimensions. See part 2.05 for chemical ground rod measurements in test well.

B. ANSI/TIA-607-D (latest published version) at the time Contract Documents were published to preclude updating versions periodically.

2.05 CHEMICAL GROUND TEST WELL/ROD:

A. General

1. Self-contained XIT Grounding System(s)using electrolytic action to enhance the grounding performance shall be provided where specifically indicated on the drawings.
2. The ground rod shall operate by hygroscopically extracting moisture from the air to activate the electrolytic process improving performance.
3. Ground rod system shall be U.L. listed and manufactured for ten years or more.
4. Ground rod system shall be 100% self-activating, sealed and maintenance free. No additions of chemical or water solutions required.

B. Electrode Unit

1. All copper XIT ground rod shall consist of a 2" nominal diameter hollow copper tube with a nominal wall thickness of .083". The tube shall be permanently capped on the top and bottom. Air breather holes shall be provided at the top and drainage holes shall be provided at the bottom of the tube for electrolyte drainage into the surrounding backfill material (Lynconite II or Lyncole Grounding Gravel).
2. The XIT rod shall be filled from the factory with non-hazardous Calsolyte salts to enhance grounding performance.
3. The XIT ground rod shall be a minimum of ten feet long for straight (vertical) installation.
4. A stranded 4/0 AWG copper ground (or as specified) wire shall be exothermically welded to the side of the rod, near the top, for the electrode to grounding conductor connection.

C. Protective Cover Box

1. Fibrelyte composite box for light duty traffic applications. Includes bolt down flush cover with "breather" holes, XIT model XB-12F.

D. Backfill Material Lynconite II:

1. Natural volcanic, non-corrosive form of Lynconite II clay grout backfill material free of polymer sealants. Quantity of 50 lb. bags varies with the length of the diameter of the hole.

2. Shall absorb approximately 13 gallons of water per 50-lb bag for an optional 320% a solids density at a mixed coverage 2.1 cu. ft. per bag.

3. Ph value 8-10 with maximum resistivity of 60 ohm-cm at 30% solids density.

E. Lyncole Grounding Gravel:

1. Natural volcanic, non-corrosive form of Lynconite clay grout pelletized backfill material free of polymer sealants, supplied in 50 lb bags.

2. Lyncole Grounding Gravel is an alternate grounding backfill used where Lynconite II cannot be used due to site conditions, installation requirements, standing water or other situations requiring use of this alternate grounding backfill.

F. Lyncole XIT for chemical ground rod/well system:

2.06 MANUFACTURER OR APPROVED EQUAL:

A. Copperweld.

B. Cadweld.

C. Burndy.

D. Harge

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Install ground system as indicated, in accordance with the applicable requirements of the National Electrical Code, the National Electrical Contractors Association's "Standard of Installation", and quality craftsmanship.

B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Install test wells as required per drawings.

C. In feeder and branch circuits, provide a separate, insulated green equipment grounding conductor. Terminate each end on a grounding lug, bus, or bushing.

D. Connect grounding electrode conductors to metal water pipe where metal pipe is available and accessible using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

E. Install exothermic welded ground connectors where they are concealed or inaccessible.

F. Ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the cover plate; or by the use of an approved grounding yoke type receptacle.

G. No strap grounding clamps shall be used; connections requiring bolting shall be made up with monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.

H. Install internal ground wire on liquid tight flexible metal conduit with grounding bushings.

I. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors.

J. The neutral of each transformer shall be bonded to system ground at one point only. This point shall be ahead of the first secondary protective device. See transformer specifications.

K. Connect grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection points below finished grade. Below grade connection shall be exothermic-welded type connectors as manufactured by Cadweld, Thermoweld. In manhole or thru slabs, install ground rods with 4 to 6 inches above the floor with connections of grounding conductors fully visible and accessible.

L. Isolated Grounding Systems: Use insulated equipment grounding conductor and connect only to separate grounding bus, at first panel.

M. Provide grounding and bonding at CPS's metering equipment and pad-mounted transformer in accordance with CPS's requirements if utility is involved.

N. Interconnection of underground metallic piping systems shall include water service, firewater service, gas and conduit.

3.02 SYSTEM DESCRIPTION

A. Ground the electrical service neutral at service entrance equipment. Provide a main bonding jumper between the neutral and ground bus of the service entrance equipment where permitted per NEC. Provide a separate grounding electrode conductor in conduit with grounding bushings on both conduit ends from the switchgear to the master ground bus-bar (MGBB) at the main electrical room. Bond MGBB to cold water metallic service pipe in contact with at least 10 feet of earth, and connect to opposite points of the building grounding ring (i.e. counterpoise) system by two main grounding conductors..

B. Provide ground bus-bar, wall-mounted on insulated supports at [xx'-xxx"] AFF in electrical rooms, and radially connected to a master ground bus-bar in the main electrical room.

C. Separately Derived Systems: Ground the neutral of each separately derived system in accordance with NEC-250.30.

D. Provide communications system-grounding conductor at point of service entrance and connect to separate grounding electrode. Bond together the communications system grounding electrode and the electrical service-grounding electrode. Separate grounding systems without interconnecting bonds or jumpers are prohibited.

E. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

3.03 SYSTEM GROUND

A. System Neutral. Where a system neutral is used, ground the system neutral as required by NEC Article 250 and as indicated on Drawings. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.

B. Size. Size the system grounding electrode conductors as indicated on plans or as required by article 250 of the NEC, whichever is greater.

C. Install grounding electrodes around exterior perimeter of building, a minimum of 3 feet outside the foundation of the building or facility. Space grounding electrodes at a distance between electrodes of at least twice their driven depth. Bond ground rods together with the building ground ring (counterpoise). Install grounding electrode conductor in undisturbed earth, a minimum of 2 feet below excavated depth of building structural mat, crawlspace, or sub-grade.

D. Depth: Bury grounding electrode conductors below grade to comply with NEC 250. Minimum depth 30 inches unless noted otherwise.

E. Provide grounding electrode conductor pigtails at each ground rod for connection to building structural steel. Place PVC sleeves through foundation at column locations. Provide minimum 12 feet of excess pigtail above the building foundation or structural mat, prior to placement of concrete. Coil pigtail conductors and support above finished level of mat or foundation during concrete pour to prevent excess pigtail from being embedded or cemented in concrete.

F. Provide main grounding electrode conductor pigtails at two locations on opposite sides of building for connection to power system neutral. Size main grounding electrode conductors as indicated on Drawings, minimum 4/0 AWG green-insulated copper conductor with Class-B stranding where not otherwise indicated. Provide larger conductors where indicated on Drawings. Place PVC sleeves through foundation and structure. Provide a minimum of 12 feet of excess pigtail above the building foundation or structural mat, as finally installed. Coil and support main grounding electrode conductor pigtails above finished level of mat or foundation during concrete pour to prevent excess conductor from being embedded or cemented in concrete. Connect grounding electrode conductors to main ground bus-bar at main electrical room. Connect power system neutral to main ground bus-bar at main electrical room. Provide test well for main grounding electrode conductor at each connection to ground rod, with reversible compression-type clamp.

G. Separately Derived Systems. Ground neutrals of separately derived systems such as generators and transformers in accordance with NEC 250 as required by the Grounding Electrode Conductor table and as indicated on Drawings.

1. For each separately derived system, ground the neutral to system ground via the nearest ground busbar specifically provided for the purpose of grounding power distribution systems. Use un-spliced grounding conductor from the neutral of the separately derived system to the ground busbar.

2. Grounding conductors shall be as short and straight as possible, protected from mechanical damage, without splice or joint except as permitted by NEC 250.

3. Transformers: Bond the center point (neutral or X0 terminal) of each wye-connected transformer to system ground at one point only. This point shall be ahead of the first overcurrent protective device (OCPD) connected to the secondary winding of the transformer. Refer to the applicable transformer specification for additional requirements.

3.04 SUPPLEMENTAL GROUND:

A. Supplementary Grounding Electrode: Where indicated on Drawings, provide supplementary grounding electrodes (ground rods) and bond to equipment grounding conductors per NEC 250. Where larger bonding jumpers and/or conductors are indicated on Drawings, provide the size shown. 3.5 EQUIPMENT GROUND: A. Electrical Rooms: Provide a ground bus in electrical rooms, and at other locations indicated on Drawings.

1. Mount busbar 8 feet above finished floor and a minimum of 1 inch from wall.

2. Connect busbar by grounding conductor to the main ground busbar at the main electrical room. Size grounding conductor as shown on Drawings. Where size is not indicated, use grounding conductor with cross-sectional area equivalent to the ground busbar.

3. Connect noncurrent-carrying metallic parts of electrical equipment and enclosures in the room, to the ground bus.

4. Bond grounding conductors to the bus as further indicated on Drawings.

3.05 RACEWAY SYSTEMS AND EQUIPMENT ENCLOSURES:

A. Bond cabinets, cable trays, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, switchboards, panelboards, transformer enclosures, other electrical equipment and metallic enclosures. Bond equipment and enclosures to the continuous-grounded, metallic raceway system in addition to other specific grounding shown. Ground each outlet by the use of an approved grounding clip attached to the outlet box in such a position to be readily inspected upon removal of the cover plate, or by the use of an approved grounding yoke type receptacle.

B. Provide bonding jumpers and grounding conductors throughout the raceway system to ensure electrical continuity of the grounding system and the raceway.

C. Provide grounding-type insulated bushings for metal conduits terminating in equipment enclosures containing a ground bus. Connect the bushing to the ground bus in the equipment enclosure.

D. Provide a green insulated equipment grounding conductor for each feeder and branch circuit. Terminate each end of grounding conductor on a grounding lug, bus, or bushing

E. Provide internal grounding conductor on liquid tight flexible metal conduit ("sealtite") with ground bushings.

F. Provide a flexible bonding jumper for isolated metallic piping and ductwork and around expansion fittings and joints.

3.06 SIZE:

A. Where grounding and bonding conductors are not sized on Drawings, size the grounding conductors in accordance with NEC 250. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250.122.

3.07 TAPS, SPLICES, AND CONNECTIONS:

A. Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends.

3.08 MANHOLES:

A. Unless indicated otherwise on Drawings, provide a No. 1/0 AWG bare stranded copper ground bus in manholes. Mount bus 12 inches above floor using one-hole pipe straps 3'-0" on center. Connect bus to ground rod with a No. 1/0 AWG conductor. Bond metallic components and electrical grounding conductors to the bus using lugs or clamps.

3.09 UNDERGROUND DUCT BANK:

A. Provide bare copper grounding conductor embedded in concrete of underground duct bank for communications, utility and power systems. Bond conductor to ground lug or ground bus at each end of duct bank and within manholes.

3.10 LIGHTNING PROTECTION SYSTEM:

A. Bond together lightning protection system ground rods to building ground ring (i.e. counterpoise). Provide bonding conductors for lightning protection ground rods separate from power system grounding electrode conductors.

B. Bond together the lightning protection system ground rods and the power system grounding electrodes (i.e., ground rods) by connecting ground rods to the building ground ring (i.e. counterpoise). Make bonds at ground rods.

C. Refer to Section 26 41 00, Lightning Protection Systems.

3.11 FIELD QUALITY CONTROL:

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Testing: Test the completed grounding system by fall-of-potential method. Measure ground resistance from system grounding electrode main conductors to convenient ground reference point using suitable ground testing equipment.

C. Prepare test procedures and test forms to be used for field testing of completed grounding system. Procedures and forms shall include documentation of test equipment proposed for use in field testing of completed grounding system.

D. Resistance shall not exceed [1][5] ohm.

E. Testing points shall include measurement of ground resistance from system neutral at electrical service entrance to convenient ground reference point using suitable ground testing equipment.

F. Where measured resistance to ground exceeds [1][5] ohm, add additional ground rods to grounding system to achieve system resistance to ground of [1][5] ohm or less, and document measured resistance to ground after ground rods are added. Repeat as required to achieve resistance to ground of 1 ohm or less, at no additional cost to Owner.

G. Documentation: Submit report of field testing of completed grounding system to Architect/Engineer and to Owner's Representative.

3.12 CONFLICTS:

A. In the event a conflict exists between this specification and the referenced standards, the most restrictive is to be followed. Identify any necessary variances required to be made in order to obtain a UL Master label for the lightning protection system.

END OF SECTION 26 05 26 0005 20 0005 26

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Task	Specification	Specification Description
26 05 26 00	26 00 00 00	Electrical Demolition
26 05 26 00	26 05 00 00	Basic Electrical Materials and Methods
26 05 29 00	01 22 16 00	No Specification Required
26 05 29 00	05 40 00 00	Cold-Formed Metal Framing
26 05 29 00	05 50 00 00	Metal Fabrications
26 05 29 00	26 00 00 00	Electrical Demolition
26 05 29 00	26 05 00 00	Basic Electrical Materials and Methods

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SECTION 26 05 33 00 - RACEWAYS, CONDUITS, AND BOXES

PART 1-GENERAL

1.01 WORK INCLUDED

A. Raceways:

   1. Surface metal raceways.
   2. Multi-outlet assemblies.
   3. Wireways.
   4. Indoor service poles.

B. Conduit:

   1. Rigid metal conduit and fittings. (RGS)
   2. Intermediate metal conduit and fittings. (IMC)
   3. Electrical metallic tubing and fittings. (EMT)
   4. Flexible metal conduit and fittings.
   5. Liquid-tight flexible metal conduit and fittings.
   6. Non-metallic conduit and fittings. (underground use only)
   7. PVC coated rigid steel conduit.

C. Boxes:

   1. Wall and ceiling outlet boxes.
   2. Pull and junction boxes.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining raceway, conduit and boxes shall follow the requirement set forth by this specification.

1.02 REFERENCES

A. NFPA 70 – National Electrical Code, latest edition

B. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated

C. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated

B. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies

E. EMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

F. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

H. ANSI/NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

I. ANSI/UL 1 – Flexible Metal Conduit

J. ANSI/UL 5 – Surface Metal Raceways and Fittings

K. ANSI/UL 360 – Liquid-tight Flexible Steel Conduit

L. ANSI/UL 467 – Electrical Grounding and Bonding Equipment

M. ANSI/UL 651 – Schedule 40 and 80 Rigid PVC Conduit (underground use only)

N. ANSI/UL 797 – Electrical Metal Tubing

O. ANSI/UL 870 – Wireways, Auxiliary Gutters and Fittings

P. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated galvanized Rigid Steel Conduit and Intermediate Metal Conduit

Q. NEMA VE 1 – Metallic Cable Tray Systems

R. UL 6 – Rigid Metal Conduit

S. ANSI/UL 5C – Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits

T. ANSI/UL 498 – Attachment Plugs and Receptacles

U. ANSI/UL 943 – Ground Fault Circuit Interrupters

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00.UT, Basic Electrical Requirements, and Submittal Procedures.

B. Shop drawings consisting of a complete list of equipment and materials, which will be used for the project, including manufacturer's descriptive and technical literature, catalog cuts and installation instructions.

C. Sealing/fire stopping materials and details.

D. Surface Mounted Raceways

1. Product data

2.Scaled shop drawings indicating:

a. Wiring and connectivity of devices in raceway system

b. Wire fill of prewired or maximum wire fill of system wired in field.

c. Rough in requirements including quantity and locations of field connections

d. Manufacturer installation details and requirements

1.04 STORAGE AND HANDLING

A. Handle materials carefully to avoid damage, breaking, denting and scoring. Damaged equipment or materials shall not be installed.

B. Store materials in a clean dry space and protected from the weather.

PART 2 PRODUCTS

2.01 SURFACE METAL RACEWAY

A. Surface metal raceway shall be factory pre-assembled galvanized or aluminum steel as shown on drawings, complete including bases, removable covers, receptacles, end plates, elbows, connectors and fittings, to exact length to match the length of the cabinets, casework, utility chases, and shelving as indicated on laboratory and furniture shop drawings, and work bench details, to provide a complete system. Internal and external surfaces shall be free of nicks, cuts, sharp edges and other imperfections..

B. Size and manufacturer shall be as shown on the Drawings. The length shown on electrical drawings is diagrammatic only and is not accurate for fabrication of raceway sections. Refer to shop drawings, architectural plans, elevations, and details.

C. Finish shall be manufacturer’s standard finish.

D. Covers shall be field removable by use of a standard screwdriver, without marring the extrusion or cover finish. Raceway with two covers must allow each cover to be removed separately without access into the compartment(s) enclosed by the other cover.

E. Provide a permanent, integral, grounded metallic dividing barrier to isolate the wiring compartments in the multi-outlet raceway system per drawing as applicable. Provide divider with fittings that maintain the separation of the raceway wiring compartments.

F. Provide device brackets for mounting standard single-gang or two-gang devices within the raceway system. Devices shall have the capacity of mounting flush or in conjunction with device faceplates.

G. Provide receptacles for the respective power systems as indicated on the drawings. Refer to Section 26 27 26.UT Wiring Devices for device specifications.

2.02 MULTI-OUTLET ASSEMBLY

A. Multi-outlet assembly shall be two-piece sheet metal channel with fitted, removable cover suitable for use as a multi-outlet assembly, and comply with surface metal raceway specifications.

B. Size shall be as indicated on the Drawings.

C. Provide receptacles mounted as shown on Drawings. Label receptacles with panel and circuit numbers and color code wiring to match building.

D. Finish shall be ANSI-61 gray enamel.

E. Provide couplings, elbows, outlet and device boxes, and connectors designed for use with multi-outlet system.

2.03 WIREWAYS

A. Wireways shall be of steel construction general purpose for indoor spaces and rain tight for outdoor applications with knockouts.

B. Size shall be as indicated on Drawings.

C. Cover shall be hinged or screwed as indicated on Drawings. Rain tight wireways shall be NEMA 3R, NEMA-4, OR NEMA 4X.

D. Fittings shall be so constructed to continue the "lay-in" feature through the entire installation.

E. Provide all sheet metal parts with a rust inhibiting phosphatizing primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

2.04 CONDUIT AND FITTINGS

A. Conduit and fittings for all electrical systems on this project shall include the following:

1. Service entrance
2. Electrical power and lighting feeders
3. Electrical power and lighting circuits
4. Telephone systems (minimum 6-inch bending radius
5. Control systems (to include HVAC)
6. Fire alarm and signaling systems
7. CCTV rough-in system
8. Clock and bell system
9. Computer system rough-in
10. Sound system rough-in
11. Building management System
12. Other electrical systems

B. For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the same type indicated.

C. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, unless grounding bushings are required by N.E.C. Article 250. Grounding bushings shall have insulated throats.

D. Rigid and intermediate metal conduit shall be hot-dipped galvanized. Fittings shall be threaded type. Expansion fittings shall be OZ Type DX.

E. Electrical metallic tubing shall be galvanized. Fittings shall be all steel compression type. Expansion fittings shall be OZ Type TX.

F. Flexible metal conduit and fittings shall be zinc-coated steel.

G. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid-tight covering of flexible polyvinyl chloride (PVC). It shall be furnished with a sealing O-ring where entering an enclosure subject to moisture. Where O-Rings are used, ground type bushings shall be used in the box or enclosure.

H. Nonmetallic conduit, flex, and fittings shall be suitable for temperature rating of conductor but not less than 90°C. Nonmetallic conduit and fittings shall be molded of high impact PVC compound having noncombustible, nonmagnetic, non-corrosive and chemical resistant properties and shall be of the same manufacturer. Where located outdoors and above ground, the conduit and fittings shall be UV resistant. Solvent cement shall be of the same manufacturer as the conduit and shall be of the brush-on type. Spray solvents are prohibited. PVC coated metallic fittings shall not be permitted for PVC conduit connections. **These products are not acceptable unless specifically indicted on drawings.**

I. Crimp or set-screw type fittings are not acceptable.

J. Minimum conduit size shall be 1/2 inch.

K. PVC coated rigid steel conduit shall be externally coated with a 40 mil PVC coating and internal phenolic coating over a galvanized surface.

L. Rigid and IMC sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2.05 WALL AND CEILING OUTLET BOXES

A. Galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

  1. Minimum switchbox depth shall be 2 inches, outlet boxes minimum for electrical and voice data shall be 2 1/8 inches deep, unless approved by engineer for structural purposes.
  2. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes.
  3. Provide multi-gang outlets of single box design. Sectional boxes are not acceptable. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NEC.

B. Provide deep type cast metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with threaded conduit ends, cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket and fasteners. Provide PVC type outlet boxes only in corrosive areas rated as NEMA 13X.

C. Outlet boxes in poured concrete shall be plenum type without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

D. Provide 4-inch octagonal ceiling outlet boxes rated to support the fixture weight.

2.06 PULL AND JUNCTION BOXES

A. Boxes shall be galvanized sheet metal conforming to ANSI/NEMA OS 1 with screw-on cover and welded seams, stainless steel nuts, bolts, screws and washers.

B. Boxes larger than 12 inches in any dimension shall be panelboard code gauze galvanized steel with hinged cover.

C. Boxes shall be sized in accordance with NEC.

D. Provide cast-in-place, pre-cast concrete or die-molded fiberglass handholes/pull boxes as per design for underground installations. Cast-in-place and pre-cast boxes shall be provided with reinforcing bars with material compressive strength no less than 11,000 psi, and shall be approved by Owner/Structural Engineer.

2.07 CABLE TRAY AND FITTINGS

A. Ladder type cable trays

1. Tray: NEMA VE 1, Class 12C or as indicated on the drawings.
2. Material and Finish of Tray, Fittings, and Accessories: 6063-T6 aluminum extrusion or hot-dip galvanized after fabrication steel (ASTM A123) as indicated on Drawings.
3. Inside width: 12 inches minimum or as indicated on Drawings.
4. Inside depth: 4 inches minimum or as indicated on Drawings
5. Straight Section rung spacing: 12 inches on center or as indicated on drawings.
6. Inside radii of fittings: as indicated on Drawings
7. Accessories and Fittings: Manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
8. Provide covers on tray where exiting the top of control cabinets, communication/data cabinets, distribution panelboards and switchboards which cover vertical Sections of tray and 90 degree bend.

B. Perforated bottom cable trays

1. Tray: NEMA VE 1, Class 12C.
2. Material and Finish of Tray, Fittings, and Accessories: 6063-T6 aluminum extrusion or hot-dip galvanized steel (ASTM A123).
3. Inside Width: 12 inches minimum or as indicated on Drawings.
4. Inside depth: 4 inches minimum or as indicated on Drawings.
5. Inside radii of fittings: 12 inches, or as indicated on drawings.
6. Accessories and Fittings: Manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
7. Utilization: Data cables, control cables, telephone cables, fiber optics. Do not use for vertical sections. Vertical cables shall be installed vertical floor mounted racks.
8. Covers: Ventilated covers where indicated on the drawings.

C. Fiberglass cable trays

1. Tray: NEMA FG1
2. Material and finish of tray, fittings, and accessories: Glass fiber reinforced polyester.
3. Inside width: 12 inches minimum or as indicated on Drawings.
4. Inside depth: 4 inches minimum or as indicated on Drawings
5. Inside Radii of Fittings: 12 inches or as indicated on Drawings.

6. Accessories and Fittings: Manufacturer's standard clamps hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, and connectors.
7. Covers: Solid covers where indicated on the drawings.

D. Warning signs for cable trays

1. 1/2-inch high black letters on yellow plastic with the following wording: WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING

PART 3 EXECUTION

3.01 INSTALLATION - CONDUIT

A. Install a complete conduit system as indicated, in accordance with the applicable requirements of NEC, NEMA and the National Electrical Contractors Association's "Standard of Installation", manufacturers published recommendations, and good workmanship.

B. Cut conduit square using a saw or pipe cutter. De-burr cut ends. Joints in steel conduit must be painted with T&B Kopr shield and drawn up tight. Threads for rigid metal conduit and IMC shall be deep and clean. Running threads shall not be used. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement with brush to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum. Spray type of cement is not acceptable. Install raceway and conduit system from point of origin in outlets shown, complete with support assemblies including all necessary hangers, beam clamps, hanger rods, turnbuckles, bracing, rolls, clips angles, through bolts, brackets, saddles, nuts, bolts, washers, offsets, pull boxes, junction boxes and fittings to ensure a complete functional raceway system. Where vertical drops of conduit are made to equipment in open space, the vertical conduit shall be rigidly supported from racks supported on the floor.

C. Install rigid wall hot-dipped galvanized steel conduit or hot-dipped galvanized intermediate metal conduit for service entrance; feeders; wall or floor penetrations; mechanical rooms electrical rooms and exposed locations where there is a high potential subject to physical damage; exposed outdoor locations; damp locations or any location as per design drawing. Minimum size shall be ¾ inch. The following exceptions permitted:

1. EMT, 1/2 inch minimum
   a. In sizes, 1/2 inch minimum, up to and including 4 inch, may be used inside dry locations where not subject to mechanical damage. EMT may be used in air-conditioned spaces, such as accessible ceilings and dry wall partitions. EMT may not be used outside, in concrete, underground, in under floor spaces, in masonry walls, in locations likely to be damp, in electrical rooms subject to mechanical damage due to future installation. EMT shall not be used for medium voltage circuits.
   b. All conduits shall be concealed in walls or ceilings unless otherwise noted.
2. PVC (underground use only)
   a. Install PVC schedule 40 conduit where direct buried in earth.
   b. Type EB, Utility Duct, encased in concrete.
3. Liquid-tight
   a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Install internal ground wire on flexible conduit with grounding bushings. Maximum length shall be 6 feet minimum of 2 feet, minimum size ½ inch.
4. Flexible Metal Conduit
   a. Install standard flexible metal conduit (not liquid-tight), which shall be only used for lighting fixture whips or motor vibrations, with internal ground wire. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. Maximum length shall be

6 feet minimum of 3 feet; minimum size shall be 1/2" inch; and minimum size shall be ½ inch for lay-in light fixture whips.

D. Install conduits parallel and supported on Unistrut, or equal, trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. No raceways or boxes shall be supported using wire. Arrange conduit to maintain headroom and present a neat appearance. Conduit routes shall follow the contour of the surface it is routed on. Route exposed conduit and tray above accessible ceilings parallel and perpendicular to walls and adjacent piping. Maintain 12-inch clearance between conduit and heat sources, such as flues, steam pipes, and heating appliances. Wire ties or “wrap lock” are not permitted to support or secure conduit system. Fasten conduit with the following material:

   1. Wood screws on wood
   2. Toggle bolts on hollow masonry
   3. Bolts and expansion anchors in concrete or brick
   4. Machine screws, threaded rods and clamps on steel
   5. Conduit clips on steel joists
   6. 4-inch X 4-inch penta-treated pine installed in pitch pans on roof, spaced at intervals not to exceed 5 feet.
   7. Fittings shall be rated for the environment where they are installed.

E. Install conduits outside of building lines at a minimum depth of 30 inches below finished grade. Maintain twelve inches earth or two inches concrete separation between electrical conduits and other services or utilities underground. Encase all plastic 277/480 volt conduits with red concrete.

F. Ducts in concrete encased ductbanks shall be independently supported by interlocking module spacers by Formex or equal. Spacers shall provide 3 inches separation between adjacent ducts. Spacers shall be installed at 6 feet maximum intervals.

G. Ducts in concrete encased ductbanks shall be terminated in manholes, pull boxes, and vaults with belled fittings. A watertight tapered plug shall be furnished and installed in unused duct openings. Where terminators are installed in new work, they shall be poured-in-place.

H. Install underground conduits with sealing glands equal to OZ Type FSK exterior to the conduit and OZ type CSB, or equal internally at the point where conduits enter the building to prevent water seepage into the building.

I. Fittings shall be approved for grounding purposes or shall be jumpered with a copper grounding conductors of appropriate ampacity. Leave termination of such jumpers exposed for inspection purposes.

J. Install expansion fittings in metal and PVC conduit as follows:

   1. Conduit Crossing Building Expansion Joints:
      a. EMT all sizes
      b. IMC all sizes
      c. RMC all sizes
      d. PVC all sizes
   2. Conduits entering environmental rooms and other locations subject to thermal expansion and as required by NEC.
   3. Expansion joint fitting shall be crouse-hind type XC.

K. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

L. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture if cable or wire are not installed immediate after conduit run. Tape covering conduit ends is not acceptable.

M. Provide 200 lb. nylon cord full length in empty conduit, with tags.

N. Where conduit penetrates fire-rated walls and floors, provide pipe sleeve two sizes larger than conduit; pack void around conduit with oakum and fill ends of sleeve with fire-resistive compound or provide mechanical fire-stop fittings with UL listed fire-rating or seal opening around conduit with UL listed foamed silicone elastomer compound equal to fire-rating of floor or wall.

O. Install no more than the equivalent of three 90-degree bends between boxes. Where four 90 degree bends are required, prior approval by the Engineer is required. Use conduit bodies to make sharp changes in direction, as around beams. Conduit bodies shall be readily accessible and sized for the cables installed. Running or rolling offsets are not approved. Use factory long radius elbows for bends in conduit larger than 2-inch size. All parallel bends shall be concentric.

P. Conduit entering / exiting cable tray shall be attached to the tray rail by means of strut bolted to the rail and standard manufacturer's accessories or by use of a UL listed conduit to tray connector. Conduit shall only enter / exit tray horizontally supported within 3 feet of the tray and extend into the tray 2 inches. Conduit shall be terminated with a grounding bushing and bonded to the ground conductor routed in the tray. (The attachment to the tray shall not be considered a ground.)

3.02 INSTALLATION - SURFACE METAL RACEWAY AND MULTI-OUTLET

A. Use flathead screws to fasten channel to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings on multi-outlet assembly.

C. Maintain grounding continuity between raceway components to provide a continuous grounding path in accordance with the requirement of NEC.

3.03 INSTALLATION - WIREWAYS

A. Bolt wireways to steel channels fastened to the wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight wireway.

C. Mount rain tight wireway for exterior installation in horizontal position only.

3.04 INSTALLATION - BOXES

A. Provide electrical boxes as shown on Drawings, and as required by the NEC for splices, taps, wire pulling, equipment connections, and code compliance.

B. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

C. Electrical box locations shown on Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in.

D. Locate and install boxes to allow access

E. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation. Provide minimum 24-inch separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the two and pack openings with fiberglass.

F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Do not support junction boxes from the raceway systems. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.

G. Provide knockout plugs for unused openings.

H. Use multiple-gang boxes where more than one device is mounted together. Do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8 inch plaster covering back of box.

K. Outlet boxes for switch shall not be used as junction boxes.

L. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

M. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

N. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes, fixtures, and conduit in acoustic ceiling areas from building structures, not from acoustic ceilings. Lighting fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.

O. Set floor boxes level and flush with finish flooring material.

3.05 INSTALLATION – CABLE TRAY

A. Installation: In conformance with NEC and NEMA requirements and in accordance with manufacturer's instructions. Arrange cable tray to maintain headroom and present neat appearance. Cables shall be arranged in cable trays in a neat, workmanlike manner.

B. Cable Tray Support

1. Refer to Section 26 05 33 for cable tray support methods
2. Support cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 10 feet maximum.
3. Trays shall be level with respect to grade plus or minus 1/8-inch per 10 feet or 1/2-inch cumulative.
4. Where multiple tiers of cable tray are installed, a minimum of 100-lbs./foot fill for each cable tray shall be used to establish support requirements if limiting factor is the supporting material.
5. Unless otherwise noted, cable trays shall be supported by rigid steel brackets or trapeze type hangers.
6. In fabricating or installing cable tray supports, holes shall be drilled and cuts made with a saw.
7. Hanger materials, including threaded hanger rods, all brackets, and other structural support items shall be per Section 26 05 33, Supporting Methods and shall have sufficient strength to support the load with a safety factor of at least 3 when all trays are filled to design capacity.
8. Hanger rods shall be of 1/2-inch or larger diameter, shall be double-nutted at the lowest cable tray support and the hanger rod shall be cut off one (1) inch below the bottom nut. Cable tray support spacing shall not exceed 10 feet for ladder type trays. Hanger rods shall not be spliced. Cable trays installed on trapeze type hangers shall be braced laterally at intervals not exceeding 50 feet.

C. Where it is necessary to make field changes in the tray system, cuts shall be made with hacksaw or power saw. All sharp edges and burrs shall be removed.

D. Install warning signs at 50 foot centers along route of cable tray, in locations visible from the floor.

E. Where new cable trays are installed above, below or in-line with existing cable trays, the new cable tray shall be supported independently from the existing cable tray with new supports and framing unless approved by The University and the Structural Engineer. Maintain twelve-inch clearance between cable tray and surfaces with temperatures exceeding 104 degrees F, such as flues, steam pipes, and heating appliances. Maintain at least 6-inch clearance between cable tray and piping, ductwork or other interference. Any deviation from this must be approved by The University. It shall be the Contractor's responsibility to protect existing cable tray in the area of construction against damage throughout the construction period. Any damaged cable tray shall be replaced by the Contractor at no additional cost prior to final acceptance by The University.

F. All power cable trays shall have a continuous; No. 4/0 insulated copper, (for aluminum tray) and bare copper (for galvanized steel tray) grounding conductor run inside the tray. Bond No. 4/0 to each section of tray and fitting with an OZ Gedney type CTGC ground clamp. All communication cable trays shall have a continuous, No. 6, green insulated copper grounding conductor run inside the tray. Connect to tray at each fitting or tray section per the Drawings.

G. Maintain electrical continuity between sections of cable tray and bond cable trays at the both ends to building ground plates to provide a continuous grounding path. Install copper braided bonding jumpers around expansion joints and hinged adjustable splice plates where electrical discontinuity occurs.

H. Cable tray in designated "Corrosive" areas shall be fiberglass.

3.06 INSTALLATION - INDOOR SERVICE POLES

A. Verify that installation of ceiling suspension system and other work above finished ceiling is complete.

B. Neatly cut openings in ceiling panels.

C. Attach foot and top clamp in accordance with manufacturer’s instructions.

D. Install trim plate to enclose ceiling panel opening.

E. Install poles plumb.

F. Install grounding.

3.07 WALL AND FLOOR PENETRATIONS:

A. Core drilling shall be approved in writing by the Structural Engineer prior to execution. Avoid anchor bolt on structural column by installing “column hugging” type of unistrut support for electrical installation. PVC shall not be used for wall and floor penetration.

B. Wall penetrations for cable tray or under floor raceway shall be sealed in accordance with Specification Section 07 84 00, Fire-stopping, and Section 07 91 26, Joint Sealers.

C. Provide a 3 1/2 inch curb around block outs through concrete floors. Fire-stop per specification.

D. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof per roof manufacturer’s subcontract. Coordinate roof penetrations with the roofing contractor.

END OF SECTION 26 05 33 00

Task	Specification	Specification Description
26 05 33 00	26 00 00 00	Electrical Demolition
26 05 33 00	26 05 00 00	Basic Electrical Materials and Methods
26 05 33 13	23 05 13 00	Electrical Renovation
26 05 33 13	26 00 00 00	Electrical Demolition
26 05 33 13	26 05 00 00	Basic Electrical Materials and Methods
26 05 33 13	26 05 33 00	Raceways, Conduits, and Boxes

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SECTION 26 05 33 16 - RACEWAYS AND BOXES

1.01 GENERAL

A. Description Of Work
  1. This specification covers the furnishing and installation of raceways and boxes. Products shall be as follows or as approved by UTHSCSA. Installation procedures shall be in accordance with the product manufacturer’s recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
  1. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

C. Definitions
  1. EMT: Electrical metallic tubing.
  2. EPDM: Ethylene-propylene-diene terpolymer rubber.
  3. FMC: Flexible metal conduit.
  4. IMC: Intermediate metal conduit.
  5. LFMC: Liquid tight flexible metal conduit.
  6. NBR: Acrylonitrile-butadiene rubber.
  7. RNC: Rigid nonmetallic conduit.

D. Submittals
  1. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
  2. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
    a. Custom enclosures and cabinets.
    b. For handholes and boxes for underground wiring, including the following:
      1) Duct entry provisions, including locations and duct sizes.
      2) Frame and cover design.
      3) Grounding details.
      4) Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
      5) Joint details.
  3. Samples: For each type of exposed finish required for wireways, nonmetallic wireways and surface raceways, prepared on Samples of size indicated below.
  4. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
    a. Structural members in the paths of conduit groups with common supports.
    b. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
  5. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in UT Specs Division 26 Section(s) "Hangers And Supports For Electrical Systems" AND "Vibration And Seismic Controls For Electrical Systems". Include the following:
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      1) The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."
    b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

6. Qualification Data: For professional engineer and testing agency.
7. Source quality-control test reports.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to UTHSCSA AHJ, and marked for intended use.
2. Comply with NFPA 70.

1.02 PRODUCTS

F. Metal Conduit And Tubing
1. Rigid Steel Conduit: ANSI C80.1.
2. Aluminum Rigid Conduit: ANSI C80.5.
3. IMC: ANSI C80.6.
4. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit **OR** IMC, **as directed**.
    a. Comply with NEMA RN 1.
    b. Coating Thickness: 0.040 inch (1 mm), minimum.
5. EMT: ANSI C80.3.
6. FMC: Zinc-coated steel **OR** Aluminum **OR** Zinc-coated steel or aluminum, **as directed**.
7. LFMC: Flexible steel conduit with PVC jacket.
8. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
    a. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    b. Fittings for EMT: Steel **and** compression type.
    c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
9. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

G. Nonmetallic Conduit And Tubing
1. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
2. LFNC: UL 1660.
3. Fittings for RNC: NEMA TC 3; match to conduit type and material.
4. Fittings for LFNC: UL 514B.

H. Optical Fiber/Communications Cable Raceway And Fittings
1. Description: Comply with UL 2024; flexible type, approved for plenum **OR** riser **OR** general-use, **as directed**, installation.

I. Metal Wireways
1. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 **OR** 12 **OR** 3R, **as directed**, unless otherwise indicated.
2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
3. Wireway Covers: Hinged type **OR** Screw-cover type **OR** Flanged-and-gasketed type **OR** As indicated, **as directed**.
4. Finish: Manufacturer's standard enamel finish.

J. Nonmetallic Wireways
1. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with

captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
OR
Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

K. Surface Raceways
   1. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected **OR** Prime coating, ready for field painting, **as directed**.
   2. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected from manufacturer's standard **OR** custom, **as directed**, colors.

L. Boxes, Enclosures, And Cabinets
   1. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
   2. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy **OR** aluminum, **as directed**, Type FD, with gasketed cover.
   3. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
   4. Metal Floor Boxes: Cast metal **OR** Sheet metal, **as directed**, fully adjustable **OR** semi-adjustable, **as directed**, rectangular.
   5. Nonmetallic Floor Boxes: Nonadjustable, round.
   6. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
   7. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum **OR** galvanized, cast iron, **as directed**, with gasketed cover.
   8. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
      a. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
      b. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint, **as directed**.
   9. Cabinets:
      a. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
      b. Hinged door in front cover with flush latch and concealed hinge.
      c. Key latch to match panelboards.
      d. Metal barriers to separate wiring of different systems and voltage.
      e. Accessory feet where required for freestanding equipment.

M. Handholes And Boxes For Exterior Underground Wiring
   1. Description: Comply with SCTE 77.
      a. Color of Frame and Cover: Gray **OR** Green **as directed**.
      b. Configuration: Units shall be designed for flush burial and have open **OR** closed **OR** integral closed, **as directed**, bottom, unless otherwise indicated.
      c. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
      d. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
      e. Cover Legend: Molded lettering, "ELECTRIC" **OR** "TELEPHONE" **OR** as indicated for each service, **as directed**.
      f. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
      g. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
   2. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

3. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
4. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete **OR** reinforced concrete **OR** cast iron **OR** hot-dip galvanized-steel diamond plate **OR** fiberglass, **as directed**.

N. Sleeves For Raceways
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
3. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.
4. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping".

O. Sleeve Seals
1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
    a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
    b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
    c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

P. Source Quality Control For Underground Enclosures
1. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
    a. Tests of materials shall be performed by a independent testing agency.
    b. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
    c. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

1.03 EXECUTION

Q. Raceway Application
1. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
    a. Exposed Conduit: Rigid steel conduit **OR** IMC **OR** RNC, Type EPC-40-PVC **OR** RNC, Type EPC-80-PVC, **as directed**.
    b. Concealed Conduit, Aboveground: Rigid steel conduit **OR** IMC **OR** EMT **OR** RNC, Type EPC-40-PVC, **as directed**.
    c. Underground Conduit: RNC, Type EPC-40 **OR** 80, **as directed**,-PVC, direct buried.
    d. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC **OR** LFNC, **as directed**.
    e. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R **OR** 4, **as directed**.
    f. Application of Handholes and Boxes for Underground Wiring:
        1) Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete **OR** Fiberglass enclosures with polymer-concrete frame and cover **OR** Fiberglass-reinforced polyester resin, **as directed**, SCTE 77, Tier 15 structural load rating.

      2) Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units **OR** Heavy-duty fiberglass units with polymer-concrete frame and cover, **as directed**, SCTE 77, Tier 8 structural load rating.
      3) Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

2. Comply with the following indoor applications, unless otherwise indicated:
   a. Exposed, Not Subject to Physical Damage: EMT **OR** ENT **OR** RNC, **as directed**.
   b. Exposed, Not Subject to Severe Physical Damage: EMT **OR** RNC identified for such use, **as directed**.
   c. Exposed and Subject to Severe Physical Damage: Rigid steel conduit **OR** IMC, **as directed**. Includes raceways in the following locations:
      1) Loading dock.
      2) Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      3) Mechanical rooms.
   d. Concealed in Ceilings and Interior Walls and Partitions: EMT **OR** ENT **OR** RNC, Type EPC-40-PVC, **as directed**.
   e. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   f. Damp or Wet Locations: Rigid steel conduit **OR** IMC, **as directed**.
   g. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
   h. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
   i. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway **OR** Riser-type, optical fiber/communications cable raceway **OR** Plenum-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
   j. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel **OR** nonmetallic, **as directed**, in damp or wet locations.
3. Minimum Raceway Size: 1/2-inch (16-mm) **OR** 3/4-inch (21-mm), **as directed**, trade size.
4. Raceway Fittings: Compatible with raceways and suitable for use and location.
   a. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   b. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
5. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
6. Do not install aluminum conduits in contact with concrete.

R. Installation
1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
2. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
3. Complete raceway installation before starting conductor installation.
4. Support raceways as specified in UT Specs Division 26 Section(s) "Hangers and Supports for Electrical Systems".
5. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
6. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
7. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
8. Raceways Embedded in Slabs:

   a. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   c. Change from RNC Type EPC-40-PVC, to rigid steel conduit, or IMC before rising above the floor.

9. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
10. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
11. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
12. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
    a. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
    b. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
    c. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
13. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    b. Where otherwise required by NFPA 70.
14. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
    a. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
        1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
        2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
        3) Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
        4) Attics: 135 deg F (75 deg C) temperature change.
    b. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
    c. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
15. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, **as directed**, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
    a. Use LFMC in damp or wet locations subject to severe physical damage.
    b. Use LFMC in damp or wet locations not subject to severe physical damage.
16. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
17. Set metal floor boxes level and flush with finished floor surface.

18. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

S. Installation Of Underground Conduit
   1. Direct-Buried Conduit:
      a. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in UT Specs Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
      b. Install backfill as specified in Division 31 Section "Earth Moving"
      c. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in UT Specs Division 31 Section "Earth Moving".
      d. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
      OR
      Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
         1) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
         OR
         For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
      e. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

T. Installation Of Underground Handholes And Boxes
   1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
   2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
   3. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
   4. Install handholes and boxes with bottom below the frost line, <**Not less than 12"**> below grade.
   5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
   6. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

U. Sleeve Installation For Electrical Penetrations
   1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping".
   2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
   3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   4. Rectangular Sleeve Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

    b. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

5. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
6. Cut sleeves to length for mounting flush with both surfaces of walls.
7. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
8. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.
9. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies, **as directed**.
10. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to UT Specs Division 07 Section "Joint Sealants" for materials and installation.
11. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with UT Specs Division 07 Section "Firestopping".
12. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
13. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
14. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

V. Sleeve-Seal Installation

1. Install to seal underground, exterior wall penetrations.
2. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

W. Firestopping

1. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Firestopping".

X. Protection

1. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
    a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
    b. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33 1605 33 16

Task	Specification	Specification Description
26 05 33 16	23 05 13 00	Electrical Renovation
26 05 33 16	26 00 00 00	Electrical Demolition
26 05 33 16	26 05 00 00	Basic Electrical Materials and Methods
26 05 33 16	26 05 33 00	Raceways, Conduits, and Boxes
26 05 33 23	26 00 00 00	Electrical Demolition
26 05 33 23	26 05 00 00	Basic Electrical Materials and Methods
26 05 33 23	26 05 33 00	Raceways, Conduits, and Boxes
26 05 39 00	26 00 00 00	Electrical Demolition
26 05 39 00	26 05 00 00	Basic Electrical Materials and Methods

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SECTION 26 05 53 00 - ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 WORK INCLUDED

A. Nameplates and tape labels

B. Wire and cable markers

C. Conduit color coding and labeling

1.02 REFERENCES

A. NFPA 70 – National Electrical Code (latest edition)

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00.UT, Basic Electrical Requirements, and Division 01 for submittal requirement.

  1. Furnish nameplate identification schedules listing equipment type and nameplate data with letter sizes and nameplate material.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. W.H. Brady Co.

B. Carlton Industries

C. Seton Name Plate Co.

D. Thomas & Betts

2.02 MATERIALS

A. Equipment Nameplates:

  1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.
  2. For emergency equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.
  3. For UPS powered equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on an orange background.
  4. For fire alarm system provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.
  5. For security and CCTV system panels, provide engraved three-layer laminated plastic nameplates with white letters on a blue background.

B. Underground Warning Tape

  1. Manufactured polyethylene material and unaffected by acids and alkalines.
  2. 3.5 mils thick and 6 inches wide.
  3. Tensile strength of 1,750 psi lengthwise.
  4. Printing on tape shall include an identification note BURIED ELECTRIC LINE, and a caution note CAUTION. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background.

C. Conductor Color Tape and Heat Shrink:

1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.
2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or enclosure. Variations to the cable color coding due to standard types of wire or cables are not acceptable.

D. Conduit Labels (5 kV and 15 kV Conduits, 38KV conduits Only): 2-inch black letters on yellow background reading "DANGER - 4160 VOLTS" or "DANGER – 13,800 VOLTS" or “DANGER 34,500 VOLTS”. Labels shall have adhesive backing, and shall be installed at intervals not exceeding 50 feet and on all pull boxes located to be visible from floor.

E. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2" lettering.

F. Tape Labels: Thermal adhesive tape, with minimum 1/4-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes, larger than 4”x4”, and manual motor starter units, etc, showing panel and circuit.

1. Black letters on white background for normal power.
2. White letters on red background for emergency/standby power.
3. White letters on orange background for UPS power.
4. Fire alarm conduit: Red tape.
5. Telecommunications conduit: Blue tape.

G. 4”x4” J-Box Labels: Label with Black Sharpie with clear letters, to include panel, circuit and voltage.

PART 3 EXECUTION

3.01 INSTALLATION

A. Degrease and clean surfaces to receive nameplates or tape labels.

B. Install nameplates parallel to equipment lines.

C. Secure plastic nameplates to equipment fronts using screws or rivets. Use of adhesives shall be per Owner’s approval. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

3.02 WIRE IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits. Label control wire with number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

B. Conductors for power circuits to be identified per the following schedule, for new construction and to match existing for remodel and finish out.

	System Voltage			
Conductor	480/277V	208/120V	240/120V High Leg	Medium Voltage
Phase A	Brown	Black	Black	One White Band
Phase B	Purple	Red	Orange	Two White Bands
Phase C	Yellow	Blue	Blue	Three White Bands
Neutral	Gray	White	White	N/A
Grounding	Green	Green	Green	Green

IG	N/A	Green w/Yellow	Green w/Yellow	N/A

3.03 NAMEPLATE ENGRAVING SCHEDULE

A. Provide nameplates of minimum letter height as scheduled below. Nameplate schedules shall be submitted to owner for approval.

1) All manufacturers shall follow this organization.
   a. Line One- Name (Tag) shown on PM System
   b. Line Two- Fed from (Panel, Circuits and Room)

B. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4-inch; identify source to device and the load it serves, including location.

C. Dry Type Transformers Not in Substations: 3/8-inch; identify equipment designation. 1/4-inch; identify secondary load.

D. Automatic Transfer Switches: 3/8-inch; white letters and red background; identify equipment designation 1/4-inch; identify voltage rating, normal source, standby source and load served including location.

E. Panelboards: 3/8-inch; identify equipment designation. 1/4 -inch; identify source, and bus rating.

F. Individual circuit breakers in panelboards shall identify receptacle or load and location.

3.04 ENCLOSURE COLOR CODING

A. The following systems shall have each junction and pull box cover completely painted per the following:

System	Color of Box Cover
Ethernet Backbone	Blue
Telecommunications	Brown
FCMS	Green
Emergency Power	Red
Security**	White
Fire Alarm	Red and marked F.A.
Clock	Fluorescent Violet
U.P.S.	Fluorescent Pink

**Security shall include, but not be limited to, the following systems:

- Card Access
- Duress Alarms
- Perimeter Door Alarms
- CCTV

END OF SECTION 26 05 53 0005 50 0005 53

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Task	Specification	Specification Description
26 05 53 00	26 00 00 00	Electrical Demolition
26 05 53 00	26 05 00 00	Basic Electrical Materials and Methods
26 05 83 00	26 00 00 00	Electrical Demolition
26 05 83 00	26 05 00 00	Basic Electrical Materials and Methods
26 05 83 00	26 05 19 00	Cable, Wire, and Connectors, 600 Volt
26 09 00 00	26 00 00 00	Electrical Demolition
26 09 23 00	26 00 00 00	Electrical Demolition
26 20 00 00	26 00 00 00	Electrical Demolition
26 21 13 00	26 00 00 00	Electrical Demolition
26 21 13 00	26 05 00 00	Basic Electrical Materials and Methods
26 21 13 00	26 05 19 00	Cable, Wire, and Connectors, 600 Volt
26 22 00 00	26 00 00 00	Electrical Demolition

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SECTION 26 22 13 00 - DRY TYPE TRANSFORMERS

PART 1 – GENERAL

1.01 WORK INCLUDED

This Section includes enclosed dry type distribution transformers rated 600 volts and less, sizes up to 500 kVA.

A. High Efficiency Dry Type Copper-wound or aluminum-wound transformers meeting US Department of Energy 2016 mandated minimum efficiency.

B. Compliance with full specification is required.

C. Basic compliance with NEMA TP1/EPACT2005, NEMA Premium, CEE Tier 1, is not sufficient to meet this specification due to the following:

1. Efficiencies must meet or exceed the US DOE 2016 minimum requirement
2. No load losses must comply with those defined in this specification
3. Efficiency at low load and under nonlinear K-Rated loads, where K-Rating indicated in Drawings, load must meet the minimum requirements of this specification
4. K listing, k rating as indicated in drawings, per UL 1561 is required
5. Comprehensive testing under linear and nonlinear loading is required to verify specified performance
6. Performance submittals are required

D. Work under this Section is subject to requirements of the Contract Documents including the Uniform General Conditions, Supplementary General Conditions, and Division One Sections.

E. All work covered by this Section shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

F. Drawings and general provisions of the Contract, including Terms and Conditions, Supplementary Conditions, Special Conditions, and other Division One Sections, apply to this Section.

1.02 REFERENCES

A. Unless specifically stated, each reference below shall be the latest published edition.

B. US Department of Energy, 10 CFR Part 431. Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule

C. DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.

D. NSI/NEMA ST 20 - Dry Type Transformers for General Applications.

E. NEMA Premium Efficiency Transformers Program

F. Consortium for Energy Efficiency (CEE): Specification for Low-Voltage, Dry- Type Distribution Transformers

G. PACT 2005 – United States Energy Policy Act 2005 / NEMA TP1 - Guide for Determining Energy Efficiency for Distribution Transformers

H. NSI/NEMA TP-2 – Standard Test Method for Measuring Energy Consumption of Distribution Transformers

I. IEEE C57.110 – IEEE Recommended Practice for establishing transformer capability when feeding nonsinusoidal load currents

J. IEEE Std C57.12.91 - Standard Test Code for Dry-Type Transformers

K. IEEE-1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

L. LEED – Leadership in Energy and Environmental Design, U.S. Green Building Council.

M. ISO 9001 – International Standards Organization - Quality Management System

N. ISO 14001 – International Standards Organization - Environmental Management System

O. ISO 17025 – International Standards Organization - General requirements for the competence of testing

1.03 RELATED SECTIONS

D. Section 26 05 26, Grounding.

E. Section 26 05 33, Raceways and Boxes for Electrical Systems

F. Section 26 05 29, Metal Framing and Supports.

G. Section 26 05 73, Overcurrent Protective Device Coordination and Arc Flash Study.

1.04 SUBMITTALS

A. Submit product data including the following:

1. Test Reports per US DOE 10 CFR Part 431, NEMA TP2, of previously manufactured units – representative of the kVA range on the project, tested in ISO 17025 Certified Efficiency Test Lab, signed by test engineer, documenting history of production capability to comply with performance requirements of this specification.
2. Test Reports per factory ISO Nonlinear Load Test Program, signed by factory test engineer of previously manufactured units – representative of the kVA range on the project, tested in ISO 17025 Certified Efficiency Test Lab, documenting history of production capability to comply with performance requirement of this specification.
3. ISO 17025 Efficiency Test Lab Certificate where testing is performed.
4. Insulation system impregnant data sheet as published by supplier.
5. Construction details including enclosure dimensions, kVA rating, primary & secondary nominal voltages, voltage taps, BIL, unit weight, k-rating
6. Basic Performance characteristics including insulation class, temperature rise, core and coil materials, impedances & audible noise level, unit weight
7. Documentation of UL listing of 2” clearance from ventilated surfaces
8. Inrush Current (typical 3 cycle recovery)
9. Short Circuit Current data: Primary & Secondary
10. Efficiency, Loss & Heat output Data
11. No load and full load losses per NEMA ST20
12. Linear load data @ 1/6 load
13. Linear load data @ 1/4, 1/2, 3/4 & full load
14. Linear Load efficiency @ 35% loading tested per NEMA TP-2.
15. Efficiency under K-rating load profile at 16.7%, 25%, 50%, 75%, 100% of nameplate rating, where k rating is indicated in drawings.

16. Copy of ISO 14001:2004 Certification
17. Copy of ISO 9001:2008 Certification
18. Documentation that materials used for shipment packaging meet the environmental requirements of this specification.

1.05 DELIVERY, STORAGE AND HANDLING

A. Store and protect products

B. Store in a warm, dry location with uniform temperature. Cover ventilation openings to keep out dust, water and other foreign material.

C. Handle transformers using lifting eyes and/or brackets provided for that purpose. Protect against unfavorable external environment such as rain and snow, during handling.

1.06 WARRANTY

A. In addition to the requirements of the Uniform General Conditions, provide a 10 year pro-rated warranty against defects in materials and workmanship, with limited liability.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/PRODUCT

A. Square D, Cutler Hammer, General Electric, Powersmiths International Corp.

B. Manufacturers wishing to have products evaluated for acceptability and conformance with the performance requirements of this specification, shall provide detailed compliance and/or exception statements, along with the documentation required in the submittal section, including test documentation, signed by an engineer, that confirms that the transformer(s) meets the specified performance.

C. Failure to provide the required documentation no less than 7 days prior to the bid date will disqualify products from consideration for this project.

2.02 RATINGS

A. Compatibility: This product must facilitate the ability of the electrical system to supply a sinusoidal voltage in order to improve the long-term compatibility of the electrical system with all types of linear and nonlinear connected loads today and in the future. All national and international standards on harmonics and power quality set limits on levels of voltage distortion to maintain compatibility.

B. Copper-wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to UL1561, NEMA

ST20 and other relevant NEMA, UL and IEEE standards; 200% rated neutral, where indicated in drawings; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be UL Listed and CSA Approved. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL. Aluminum wound is acceptable granted all other requirements are satisfied. .

C. Insulation System:

1. Shall be NOMEX-based with an Epoxy Co-polymer impregnant for lowest environmental impact, long term reliability and long life expectancy
2. Class: 220 degrees C
3. Impregnant Properties for low emissions during manufacturing, highest reliability and life expectancy
4. Epoxy co-polymer

5. VOC: less than 1.65 lbs/gal (low emissions during manufacturing)
6. Water absorption (24hrs @25C): less than 0.05% (superior insulation, longer life)
7. Chemical Resistance: Must have documented excellent performance rating by supplier
8. Dielectric Strength: minimum of 3200 volts/mil dry (for superior stress, overvoltage tolerance)
9. Dissipation Factor: max. 0.02 @25C to reduce aging of insulation, extending useful life

D. Operating Temperature Rise: 115-degree C in a 40-degree C maximum ambient

E. Noise levels:

1. 3 dB quieter than NEMA ST-20
2. Every unit to meet this noise level. Production Test every unit. Data to be available upon request.

F. UL Listed & Labeled K-Rating: K-rating as indicated in drawings or higher

G. Enclosure type: Indoor Ventilated NEMA 1, drip-proof [or select other: sprinkler-proof, outdoor padmount, secure, outdoor public, totally enclosed, stainless steel]

H. Rear Clearance: UL Listed for 2” clearance from the wall rather than standard 6”. This capability shall be explicitly described on the nameplate of each unit.

I. Exceed minimum efficiency requirements of US Department of Energy, 10 CFR Part 431, April 18, 2013, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule which takes effect January 1, 2016, and comply with the table of Maximum No Load Losses, efficiency requirements at 1/6 load, efficiency at 35% load per 10 CFR Part 431, and efficiency at 25% load under a K-7 load profile, or applicable K-Rating.

kVA	No load losses (Watts)	Efficiency @ 1/6 load (%)	Efficiency @ 35% load (%)	Efficiency at 25% load under K-7 nonlinear load
15	47	97.85%	98.28	98.00%
20	60	98.05%	98.34	98.10%
25	66	98.15%	98.41	98.15%
30	71	98.27%	98.50	98.30%
45	97	98.40%	98.66	98.40%
50	112	98.45%	98.67	98.42%
63	120	98.50%	98.75	98.48%
75	135	98.63%	98.82	98.60%
100	180	98.65%	98.88	98.65%
112.5	195	98.70%	98.92	98.70%
125	215	98.73%	98.94	98.72%
150	235	98.80%	98.99	98.80%
175	270	98.82%	99.02	98.82%
200	310	98.84%	99.05	98.84%
225	330	98.90%	99.09	98.90%
250	365	98.91%	99.10	98.92%

300	400	98.95%	99.15	99.00%
400	530	98.96%	99.20	99.02%
450	600	98.97%	99.22	99.03%
500	650	99.00%	99.25	99.05%
600	800	99.01%	99.28	99.07%
750	875	99.10%	99.32	99.10%
850	950	99.11%	99.34	99.11%
1000	1200	99.12%	99.36	99.12%

J. Voltage Taps: For transformers 15kVA-750kVA, provide two 2-1/2% full capacity taps above and four 2 1/2% taps below nominal primary voltage.

K. Impedance: Between 3.0% and 6.0% unless otherwise noted.

L. Grounding: Ground the core of the transformer to the enclosure with a flexible grounding conductor sized according to NEC requirements.

M. Maximum Footprint for 115-degree C rise model in a NEMA 1 enclosure:

1. 18” Wide x 17” Deep x 27” High for 15kVA.
2. 26” Wide x 18” Deep x 30” High for 20, 30, 45kVA
3. 33” Wide x 22” Deep x 40” High for 50, 63, 75, 100, 112.5kVA
4. 38” Wide x 27” Deep x 48” High for 125,150, 175, 200kVA
5. 38” Wide x 32” Deep x 52” High for 225, 250, 300kVA
6. 52” Wide x 38” Deep x 61” High for 400, 450, 500kVA
7. 64” Wide x 47” Deep x 67” High for 600, 750kVA
8. 64” Wide x 53” Deep x 67” High for 850, 1000kVA

N. Integrated Rotatable Infrared (IR) Viewing Port to address NFPA 70E/CSA-Z462 Arc Flash Standard

1. Provide integrated rotatable IR viewing port that provides single point viewing point that enables the thermal scanning of all live connections including primary and secondary feeder terminations and taps without requiring opening of the transformer enclosure or exposure to live parts.
2. The port shall be easily usable by a wide variety of makes and models of commercially available thermal scanning devices, without requiring any proprietary connectors, adapters or other components.
3. Basis of performance: Powersmiths Rotatable IR Viewing Port.
4. For the installation of one or more fixed IR windows to be considered an acceptable alternative on this project, the transformer manufacturer shall provide detailed drawings prepared by a qualified engineer detailing how all live terminals will be viewable. The manufacturer shall commit that should all terminals not be viewable once installed, the manufacturer shall rectify the situation at his own expense.
5. Infrared ports/windows must be factory installed with full manufacturer warranty. Aftermarket or contractor installed kits are not acceptable.

O. Lug Kit: supply with Compression lugs configured as specified at time of order

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver transformers individually wrapped for protection and mounted on shipping skids.

B. Storage: Store transformers in a clean, dry space, elevated above grade, and protected from weather, moisture, sunlight, and dirt. Maintain factory wrapping or provide an additional heavy canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Temporary Heating: Apply temporary heat for protection from insulation moisture absorption and metallic component corrosion in accordance with paragraph 3.2B of Section 26 00 00, Basic Electrical Requirements, and according to manufacturer’s written instructions. Apply temporary heat within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

D. Stacking: Do not stack transformers directly on each other. However, a second transformer may be rack mounted above a same size or larger transformer. See spacing requirements below.

E. Work Surface: Transformers shall not be used as work tables, scaffolds, platforms, or ladders.

F. Handling: Handle transformers carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged transformers shall be rejected and not be installed on project.

G. General Provisions: Refer to Part 3 of Section 26 05 00, Basic Electrical Requirements.

3.02 INSPECTION

Installer shall examine the areas and conditions under which dry type transformers are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Install dry type transformers in locations indicated on Drawings, in accordance with the applicable requirements of the NEC, NEMA, and ANSI.

B. Set transformers plumb and level.

C. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

D. Ventilation.

   1. Provide adequate clearance around transformer for ventilation of core, coil and internal components; minimum 1 foot – 0 inch all sides unless noted otherwise.

   2. Where transformers are proposed for installation vertically one above the other, provide sufficient vertical separation between transformers to permit adequate air circulation for proper cooling of each transformer, in accordance with manufacturer recommendations. Take temperature measurements of transformers under load and document temperature rise and temperature of each transformer where mounted in a vertical arrangement. Where the temperatures exceed manufacturer’s recommendations or the requirements of this Section, relocate transformers to provide adequate cooling.

E. Verify removal of coil shipping anchor bolts before transformer is energized.

F. Check for damage and tight connections prior to energizing transformer.

3.04 FLOOR MOUNTING

A. Provide concrete pad for floor-mounted transformers. Refer to structural Drawings and specifications for design criteria. Where not otherwise indicated, and in addition to the requirements of Section 26 05 00, Electrical General Provisions, and Section 26 05 29, Hangers and Supports for Electrical Systems, construct pads of nominal 4-inch thick 2500 pound concrete reinforced with 6 inch x 6 inch steel wire mesh. Size pads 3 inches wider than transformer and chamfer edges to a ¾-inch bevel.

B. Maintain a minimum of 12 inches free air space between enclosure and walls.

C. Vibration isolation. Provide vibration and sound isolation system suitable for isolating the transformer noise from the building structure.

   1. Provide spring-type isolators in suspension system sized to support the transformer weight, one at each corner of transformer lower mounting rails. Manufacturer: Korfund/Aeroflex type LK, or accepted substitution.

   2. Use one pad type Korfund Elasto-Grip, waffle, or accepted substitution, at each corner of the transformer, below the spring-type isolators, sized for load of 50 lbs./sq.-in.

D. Secure the transformer and vibration isolators to the pad as recommended by the manufacturer.

E. Refer to Section 26 05 29, Hangers and Supports for Electrical Systems.

3.05 CONDUIT CONNECTIONS

A. Flexible Metallic Conduit. Attach incoming and outgoing conduits to the transformer enclosure with flexible metallic conduit (FMC), minimum length 24 inches.

   1. Make conduit connections to side panel of enclosure using an appropriately sized 90-degree elbow connector.

   2. Provide grounding-type coupling at each end of flexible metallic conduit. Provide a bonding jumper on outside of flexible conduit, sized per NEC Table 250.122 or NEC Table 250.66 as appropriate. The exterior bonding jumper shall be provided in addition to the grounding conductor run with the transformer circuit conductors inside the conduit. Where grounding conductor or jumper size is shown larger on Drawings, provide the larger size.

B. Liquid Tight Flexible Metallic Conduit. Where indicated, use liquid-tight flexible conduit for connections to transformer case, maximum length 6 feet, minimum length 3 feet, with slack or dip to attenuate noise transmitted through conduit.

   1. Make conduit connections to side panel of enclosure using an appropriately sized 90-degree elbow connector.

   2. Provide grounding-type coupling at each end of liquid-tight flexible conduit. Provide a bonding jumper on exterior of liquid-tight flexible conduit, sized per NEC Table 250.122 or NEC Table 250.66 as appropriate. The exterior bonding jumper shall be provided in addition to the grounding conductor run with the transformer circuit conductors inside the conduit. Where grounding conductor or jumper size is shown larger on Drawings, provide the larger size.

3.06 CABLE CONNECTIONS

A. Lugs: Make transformer cable connections with compression-type lugs suitable for termination of 90°C rated conductors. Position lugs so that field connections and wiring will not be exposed to temperature above 75°C.

B. Grounding: Ground the neutral (X0) of the transformer secondary winding in accordance with the requirements of NEC-250.30, paragraph 3.3G of Section 26 05 26, and as indicated on the Drawings. Connect equipment grounding conductors and system bonding jumper(s) to the transformer neutral (X0) bus. Provide an equipment bonding jumper from the transformer neutral (X0) bus to the transformer metallic enclosure. Expose bare metal of the transformer enclosure to ensure proper contact between the transformer enclosure and the equipment bonding jumper. The conductor should bond to the ground bar in the electrical room or closet. If the ground bar is not present, it should be added to the grounding system that originates with the service entrance duct bank.

3.07 TAP SETTING

C. Check for damage and tight connections prior to energizing transformer. Verify removal of all shipping anchor bolts and shipping supports prior to energizing transformer.

D. Measure primary and secondary voltages and make appropriate tap adjustments.

E. Select the appropriate tap setting on transformer so that the actual secondary voltage is ±1/2 of a tap span at full load.

4.01 TESTING

A. Test and record no-load amperages of all dry type transformers. Replace at no cost to Owner all transformers with no load amperage exceeding four percent of rated full load.

B. Submit record of field testing and tap settings to the Owner's Representative and to the Architect/Engineer, in accordance with the requirements of Division One and Section 26 05 00. Where not specified elsewhere, provide three copies of the record.

END OF SECTION 26 22 13 0022 10 0022 13

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Task	Specification	Specification Description
26 22 13 00	26 00 00 00	Electrical Demolition
26 24 00 00	26 00 00 00	Electrical Demolition

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SECTION 26 24 16 00 - PANELBOARDS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Distribution panelboards.

B. Branch circuit panelboards.

1.02 REFERENCES

A. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.

B. NAME KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

C. NEMA PB 1 - Panelboards.

D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

E. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment.

F. NEMA AB 3 – Molded Case Breakers and Their Application

G. ANSI/UL 67 – Electric Panelboards

H. ANSI/UL 50 – Cabinets and Boxes

I. ANSI/UL 508 – Industrial Control Equipment

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to General Requirements for submittal requirement.

B. Submit dimensioned drawings showing size, circuit breaker arrangement and equipment ratings including, but not limited to, voltage, main bus ampacity, integrated short circuit ampere rating, bus material and temperature rating of circuit breaker terminations.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver distribution panelboards in factory-fabricated water-resistant wrapping.

B. Handle panelboards carefully to avoid damage to material component, enclosure and finish.

C. Store in a clean, dry space and protected from the weather.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Eaton

B. General Electric Company

C. Square D Company

D. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

2.02 PANELBOARD CONSTRUCTION

A. General: Provide flush or surface mounted, or surface mounted deadfront circuit breaker type distribution or branch circuit panelboards with electrical ratings and configurations, as indicated on the drawings and schedules. Load center type of panelboards are not acceptable.

B. Enclosure:

1. Enclosure shall be proper NEMA type as shown on the drawings.

2. NEMA 1
    a. Back box shall be galvanized steel for flush mounted branch circuit panelboards. Back box shall have gray enamel electro-deposited finish over cleaned phoshatized steel for all other type panelbaords.
    b. Provide panelboard fronts with door in door with flush lock.
    c. Where power monitors, metering, or TVSS are specified on the Drawings, the manufacturer shall provide factory installed units and covers.
3. NEMA 3R, 3S and 12
    a. Enclosure and doors shall have gray enamel electro-deposited finish over cleaned phoshatized steel.
    b. Doors shall be gasketed and equipped with tumbler type vault lock and two trunk latches where required by UL standard. Interior trim shall consist of four pieces, each covering one gutter top, bottom and both sides.
4. Construct cabinet in accordance with UL 50. Use not less than 16-guage galvanized sheet steel, with all cut edge galvanized. Provide a minimum 4-inch gutter wiring space on each side. Provide large gutter where required to accommodate the size and quantity of conductors to be terminated in the panel, and where required by code.
5. Exterior and interior steel surfaces shall be cleaned and finished with gray enamel over rust inhibiting phosphatized coating. Color shall be ANSI 61 gray for normal power and red for emergency power.
6. Doors shall be equipped with flush-type combination catch and key lock. All locks shall be keyed alike.
7. Branch circuit panelboards shall be 5 ¾ inches deep.
8. A plastic sleeve directory holder and panel schedule shall be mounted inside of each door.
9. Reinforce enclosure and securely support bus bars and overcurrent devices to prevent vibration and breakage in handling.
10. Rating: Minimum integrated short-circuit rating, voltage and current rating as shown on drawings.
11. Labeling: The Contractor shall furnish and install engraved, laminated plastic nameplates on the trim per Section 26 05 53, Electrical Identification

C Bus:

1. Provide panelboards with rounded edge phase, neutral and ground buses, rated full capacity as scheduled on drawings. Buses shall be full-length copper and braced for the maximum available fault current as shown on drawings. Neutral bus shall be 200% rated for electronic grade panelboards.
2 Where isolated ground buses are specified or indicated, provide copper grounding bus bars mounted in the panelboard on insulated standoffs to ensure isolation from equipment ground potential. Isolated ground buses shall be drilled and tapped as appropriate for connection of the individual isolated grounding conductors. **All ground bus bars shall be copper.**
3. All lugs for phase, neutral, and ground buses shall be tin-plated copper. **AL/CU connectors are not acceptable.**
4. Panelboard shall be rated SE where required for Service Entrance duty.

2.03 SWITCHING AND OVERCURRENT PROTECTIVE DEVICES

A. Provide molded case circuit breakers with manufacturer’s standard construction, bolt on type, with integral inverse time delay thermal and instantaneous magnetic trip in each pole. Circuit breakers shall be constructed using glass reinforced polyester insulating material providing superior dielectric strength. Provide circuit breakers UL listed as Type HACR for air-conditioning equipment branch circuits.

B. Circuit breakers shall have an over center, trip-free, toggle operating mechanism that will provide a quick-make, quick-break contact action.

C. Provide handle padlock attachments on circuit breakers where indicated on drawings. Device shall be capable of accepting a single padlock. All circuit breakers shall be capable of being individually padlocked in the off position.

D. The circuit breakers shall be connected to the bus by means of solidly bolted connection. In multi-pole breakers, the phase connections on the bussing shall be made simultaneously without additional connectors or jumpers. Multi-pole breakers shall be two or three pole as specified. Handle ties are not permitted. The circuit breaker shall have common tripping for all poles.

E. All circuit breakers shall be provided with visible ON and OFF indications.

F. Provide GFI circuit breakers as indicated on drawing or per NEC requirement.

G. Breaker voltage and trip rating shall be per drawings. Breaker faceplate shall indicate UL certificate standards with applicable voltage systems and corresponding short current rating as per drawings.

H. Molded Case Circuit Breakers:

1. Breakers 400 ampere frame and less shall be manufacturer's standard industrial construction, bolt-on type, integral inverse time delay thermal and instantaneous magnetic trip. Breakers 225 ampere through 400 ampere shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.
2. Breakers 600 ampere frame and above shall be equipped with solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip.

I. Current Limiting Molded Case Circuit Breakers:

1. Breakers 100 ampere frame shall be inverse time delay thermal and instantaneous magnetic trip.
2. Breakers 250 ampere and 400 ampere frame shall be solid-state trip with built-in current transformers, solid-state trip unit and flux transfer shunt trip.
3. Current limiting breakers shall protect downstream molded case breakers. Submit manufacturer's test data proving the protection, from both peak currents and I^2T energy of downstream devices.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions and the applicable requirements of the NEC, NEMA, ANSI, the National Electrical Contractors Association's "Standard of Installation", and quality workmanship.

B. Anchor can firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secured. Direct attachment to dry wall is not permitted. Freestanding panelboards shall be installed on a concrete housekeeping pad with anchors per manufacturer's recommendation.

C. Mounting height:

1. Distribution Panelboards: As per Drawings, but such that the center of the highest operating handle is no greater than 79 inches above finished floor.
2. Branch Circuit Panelboards: As per Drawings, but such that the center of the highest operating handle is no greater than 79 inches above finished floor.
3. Where panelboards occur in groups, the tops shall be aligned if it can be done without exceeding items 1 and 2 above.

D. Install panelboards plumb. Adjust trim to cover all openings. Seal all conduit openings and cap all unused knockout holes.

E. Provide blank plates for unused open spaces in panelboards. Keep the front door closed after work to protect from damage, dirt, and debris at all times.

F. Install identification nameplates in accordance with Section 26 05 53, Electrical Identification.

3.02 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers and lugs.

B. Provide testing as indicated in Section 26 05 00 – Basic Electrical Material and Methods.

3.03 PANELBOARD SCHEDULE

A. The Contractor shall provide engraved, laminated plastic nameplates for circuit identification as indicated on the Drawings for distribution panelboards.

B. The Contractor shall provide a typed index directory inside the front door of branch circuit panelboards identifying each circuit as shown on Panel Schedule drawings. Where changes are made, the schedule shall reflect the changes. At the end of the job, these schedules shall reflect as-built record conditions**. Provide hard and digital (excel) copies to UTHSCSA of As-Built schedules.**

END OF SECTION 26 24 16 0024 16 0024 10 0024 16

Task	Specification	Specification Description
26 24 16 00	26 00 00 00	Electrical Demolition
26 24 19 00	01 22 16 00	No Specification Required
26 25 00 00	23 05 13 00	Electrical Renovation
26 27 00 00	26 00 00 00	Electrical Demolition
26 27 13 00	26 00 00 00	Electrical Demolition
26 27 16 00	01 22 16 00	No Specification Required
26 27 16 00	26 00 00 00	Electrical Demolition
26 27 16 00	26 05 33 16	Raceways And Boxes

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SECTION 26 27 26 00 - WIRING DEVICES AND FLOOR BOXES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Wiring Devices:

1. Wall switches.
2. Receptacles.
3. Device plates and box covers.
4. Wall dimmers.
5. Occupant sensors.

B. Floor boxes.

C. Wiring for HVAC in Division 23 shall meet the requirement of this specification.

1.02 REFERENCES

A. Americans with Disabilities Act (ADA)

B. ANSI/NEMA OS 1- Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

C. ANSI/UL 20 – General Use Snap Switches.

D. ANSI/UL 498 – Attachment Plugs and Receptacles.

E. ANSI/UL 943 – Ground Fault Circuit Interrupters.

F. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts maximum).

G. NEMA WD 1 – General-Purpose Wiring Devices.

H. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.

I. NEMA WD 5 - Specific-Purpose Wiring Devices.

J. Texas Accessibility Standards. (TAS)

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to General Requirements for submittal requirement.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver wiring devices individually wrapped in factory-fabricated containers.

B. Handle wiring devices carefully to avoid damage, breaking and scoring.

C. Store in a clean dry space and protected from the weather.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide factory fabricated wiring devices in the type and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection to correspond with branch circuit wiring and overcurrent protection. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.

B. Device color:

1. Switches, receptacles, and dimmers on normal power shall be white.

2. Switches, receptacles, dimmers, and faceplates on emergency power shall be red.
3. Isolated ground receptacles shall be orange.
4. Key operated switches shall be gray.
5. Provide receptacles in surface mounted raceways in colors as shown on drawings. Coordinate color of devices and device plates in other areas with the architectural finish. Refer to drawings and specifications.
6. For renovation or expansion of existing facilities, provide normal power devices and plates to match existing.

2.02 WALL SWITCHES

A. Acceptable manufacturers
   1. Cooper Wiring Devices
   2. Hubbell
   3. General Electric
   4. Leviton
   5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. Material
   1. Wall switches for lighting circuits shall be AC general use snap switch with toggle handle, 20 amperes and 120/277 volt AC with number of poles as required.
   2. Pilot light type shall be equipped with red toggle handle (glow when on), 20 amperes and 120/277 volt AC with number of poles as required.
   3. Key operated switches shall be Gray, 20 amperes and 120/277 volt AC with number of poles as required key all locks alike. Furnish keys compatible with key switch, quantity as approved by Owner, minimum of ten copies.
   4. Illuminated Emergency-Power-Off switch shall be provided with button guard equal to Allen-Bradley #800T-QA10R or approved substitutions.
   5. A listed manual switch having a horsepower rating not less than the rating of the motor and marked “Suitable as Motor Disconnect” shall be permitted to serve as disconnect means for stationary motor of ¾ horsepower or less.
   6. Switch terminal screws or connectors shall be designed to accommodate No. 10 solid conductor.

2.03 RECEPTACLES

A. Acceptable manufacturers
   1. Cooper Wiring Devices
   2. Hubbell
   3. General Electric
   4. Leviton
   5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. Material
   1. Hospital grade receptacles shall be installed in clinic, patient care and other areas required by NFPA. Tamper proof in areas serving children.
   2. Circuit and convenience duplex receptacles shall be rated 20 amperes, 125 volt AC.

3. GFCI receptacles shall be rated 20 amperes, 125 volt with integral ground fault current interrupter
4. Isolated ground duplex receptacles shall be Orange, rated 20 amperes, 125 volt.
5. Heat trace receptacles shall be Arrow-Hart #5262CRGRY with Crouse Hinds #WLRD-1 cover. Install round plug on cord supplied with heat trace to match weatherproof bushing on receptacle cover for watertight installation.
6. Specific-use receptacles shall have volts, amps, poles and NEMA configuration as noted on drawings, as required for branch circuit wiring, over current protection, and equipment application.
7. Heavy-duty lock-blade receptacles shall be NEMA WD5 heavy-duty specification grade.
8. Emergency receptacles shall be red plastic face
9. Weatherproof receptacles as specified shall be mounted in a cast steel box with gasketed, weatherproof device plate as specified.

2.04 WALL PLATES

A. Acceptable manufacturers
   1. Cooper Wiring Devices
   2. Hubbell
   3. General Electric
   4. Leviton
   5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. Material
   1. Wall plates in IT, mechanical and electrical rooms, loading docks, lab areas, and other industrial areas shall be 316 or 302 stainless steel with cutouts as required for devices indicated on drawings, unless otherwise noted. Other wall plates shall be smooth nylon, of a matching color to existing or as specified on Drawings. Where switches or outlets are shown adjacent to each other, they shall be ganged with partitions between different type services and covered by a single custom wall plate.
   2. Exposed boxes:
      a. Dry interior spaces: Use cast metal plates with cast metal box. Use heavy cadmium-plated sheet steel plates with steel boxes and copper-free aluminum with aluminum boxes. All screws shall be stainless steel. Edges of plates must be flush with edges of boxes.
      b. Other locations: Use weatherproof devices plates. Provide cast metal plates with gasketed spring door
   3. Jumbo plates are not permitted.
   4. Weatherproof cover plate shall be gasketed cast aluminum or feraloy (by Crouse-Hinds) with hinged gasketed device covers.
   5. Wall plate for isolated ground receptacles shall be silk-screened "ISOLATED GROUND".

2.05 WALL DIMMERS

A. Acceptable manufacturers
   1. Lutron
   2. Leviton
   3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. Material

1. Provide NEMA WD 2 solid-state wall-box dimmers, where indicated on drawings. Dimmers shall be complete, with linear slide-type solid-state dimming controls, and LED light level ON/OFF indicators. Dimmer shall produce IES square-law response from blackout to full brightness. Dimmer rise time shall be restricted to prevent interference with professional quality audio or video equipment. Dimmer shall be compatible with ballast per manufacturer's specification.
2. Device: White finish plastic with linear slide.
3. Voltage: As noted on drawings.
4. Power rating: Match load shown; 1000 watts minimum, larger size is required to accommodate connected loads greater than 1000watts. Load to 80% of the dimmer capacity, maximum.

2.06 FLOOR MOUNTED SERVICE FITTINGS AND BOXES

A. Acceptable manufacturers
   1. Steel City
   2. Walker
   3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. Material
   1. Floor mounted service boxes shall be flush mounted brushed aluminum housing with poke-through assembly. Provide brass cover plate with two hinged lift lids where carpeting is installed.
   2. Quantity of outlets for A/V and power per drawings.

2.07 OCCUPANT SENSORS

A. Acceptable manufacturers
   1. Wattstopper
   2. As specified on drawings
   3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in General Requirements for substitution requirement.

B. Material
   1. Self-mounting, ceiling bracket.
   2. Quad element, infrared detector behind a fresnel lens.
   3. Features
      a. Provide power packs as required.
      b. Power packs shall be by same manufacturer.
      c. Adjustable time-out delay: not greater than 15 minutes.
      d. Supplied with plenum rated low voltage wire leads for termination.
      e. Manual shutoff per sensor is required for wall switches.
   4. Control unit
      a. Enclosure: Galvanized, heavy duty for mounting to a 4 inch or 4-11/16 inch square box.
      b. Control up to (7) sensors.
      c. Power rating
         (1) 600 watts for incandescent at 120 volts.

(2) 2500 watts for fluorescent at 277 volts.

d. Supplied with plenum rated low voltage wire leads for termination.

2.08 TAPE LABELS

A. Provide tape labels in accordance with Section 26 05 53, Electrical Identification, on all receptacles and switches indicating panelboard and circuit number. White tape with 3/16 inch black letters/numbers.

PART 3 - EXECUTION

3.01 INSPECTION

A. Installer must examine the areas and conditions under which wiring devices and floor boxes are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 DEVICE COORDINATION

A. Where items of equipment are provided under other Sections of this specification or by The University, provide a compatible receptacle and/or device plate for the cap or plug, and cord of the equipment.

3.03 INSTALLATION

A. General:

1. Install wiring devices and floor boxes as indicated, in accordance with the applicable requirements of the latest release of NEC, NEMA, and ANSI.

2. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the drawings. These drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building drawings and by actual measurements during construction of the building before rough-in, subject to the approval of The University.

3. Where more than one device occurs in one outlet box, connected to different voltage systems, a barrier must be provided for isolation to meet NEC Article 800.

B. Wall Switches and Dimmers:

1. Location:

a. Install wall switches and dimmers in suitable outlet box centered at the height of 48inches above finished floor, OFF position down.

b. Where wainscot occurs at the 48" level, install device in the wall below the wainscot and as near the 48" level as possible to provide the most pleasing appearance, but in no case partially in the wainscot and partially in the wall.

c. Where shown near doors, install switches and dimmers not less than 2" and not more than 12" from door trim.

d. Verify all door swings before rough-in and locate switches and dimmers on strike side of door as finally installed.

2. Position:

a. Wall switches: Install wall switches in a uniform position so the same direction of operation will open and close the circuits throughout the project, generally up or to the left for the ON position.

b. Wall dimmers: Install dimmers in a uniform position so the same direction of operation will brighten and dim the lights throughout the project, generally up for brightest position.

3. Wall Box Dimmers:

a. De-rate ganged dimmers as instructed by manufacturer. Do not use common neutral.

b. Compatibility: Where dimmers are connected to fluorescent lights, verify with ballast manufacturer and dimmer manufacturer the suitability of the ballast for dimming applications.

c. Test: Test dimmers per manufacturer's instructions. Demonstrate that unit's function as specified. Where remote dimmers are provided, demonstrate that unit's function properly as master and remote.

d. Burn-in: Where dimmers are connected to fluorescent fixtures, operate at full brightness for the full burn-in duration as specified or recommended by the lamp manufacturer, not less than 100 hours.

C. Receptacles:

1. Location:

a. Install convenience outlets, telephone, data and TV outlets in suitable steel outlet boxes centered at the height of 18 inches above the finished floor, 6 inches above countertop or at the backsplash level, or as indicated on the drawings. Coordinate with equipment and architectural drawings.

b. Install receptacles generally where indicated on drawings. The University's representative reserves the right to make any reasonable changes in receptacle locations without change in the contract sum.

c. Install specific-use receptacles at heights shown on Drawings, or 18" AFF if not shown.

2. Position:

a. Install receptacles vertically with ground pole on top. Install receptacles horizontally, where field condition does not allow vertical installation, with ground pole on left.

3. All receptacles with 6 feet of a water source such as sinks shall be GFCI type. Arrange circuit wiring for last receptacle on circuit to be GFCI. Feed through to non-GFCI receptacles is not permitted, unless specifically shown on Drawings.

D. Plates:

1. Where cover plates do not completely conceal the rough openings for the devices, it shall be the responsibility of the General Contractor to patch, paint, etc. around the opening to the satisfaction of The University.

2. All devices and cover plates shall be plumb and parallel to adjacent surfaces or trim. Devices must be flush with the finished trim cover plates and plates must be tight to surfaces over which they are installed.

3. Where switches controlling devices that are out of sight, or where three or more switches are gang mounted, plates shall be labeled to identify items being controlled, or areas being lighted. Labeling shall be engraved 3/16-inch Condensed Gothic and shall be filled with black enamel.

E. Floor Boxes:

1. Verify locations of all floor boxes with The University before installation. Increase slab thickness at boxes if required to obtain a minimum if 1 inch of concrete below bottom of box.

2. Install floor boxes level and flush with finish flooring material. Completely envelope floor boxes in concrete except at the top.

3. Adjust covers flush with finished floor.

F. Occupant Sensors:

1. Flush mount occupant sensors through round hole cut in ceiling tile, positioning and placement per sensor manufacturer's recommendation.

2. It is the installer's responsibility to replace damaged ceiling tiles during his installation of sensor.

3. The low voltage control wiring installed above ceiling tiles shall be plenum rated or general building wiring installed in raceway system and installed tight to above structure, above other equipment and systems, and supported every 5 feet.

END OF SECTION 26 27 26 0027 20 0027 26

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Task	Specification	Specification Description
26 27 26 00	26 00 00 00	Electrical Demolition
26 27 26 00	26 05 33 16	Raceways And Boxes
26 28 00 00	26 00 00 00	Electrical Demolition

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SECTION 26 28 13 00 - FUSES, 600 VOLT

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Dual-element, current limiting Class R fuses for loads up to 600 volts, 0-600 Amps.

B. Time delay, current limiting Class L fuses for loads up to 600 volts, 601-6000 Amps.

1.02 REFERENCES

A. UL 248-12 - Standard For Safety For Low-Voltage Fuses-Part 12: Class R Fuses

B. UL 248-10 - Standard For Safety For Low-Voltage Fuses-Part 10: Class L Fuses

C. Where application of local codes, trade association standard or publications appears to be in conflict with the requirements of this Section, the Engineer shall be asked for an interpretation.

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to General Requirements for submittal requirement.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store fuses in a clean and dry space and protected from weather. DO NOT STORE OUTDOORS.

PART 2 - PRODUCTS

2.01 MATERIAL AND EQUIPMENT

A. Furnish fuses manufactured by Buss, or equal, in accordance with the following:

1. Motors and Transformers, 0 to 600 Amp:
    a. 250 volt - Buss LPN-RK, UL Class RK1.
    b. 600 volt - Buss LPS-RK, UL Class RK1.
2. Lighting Loads, 0 to 600 Amp:
    a. 250 volt - Buss KTN-R, UL Class RK1.
    b. 600 volt - Buss KTS-R, UL Class RK1.
3. All Applications, 601 to 6000 Amp:
    a. 600 volt - Buss KRP-C, UL Class L.

B. Size fuses serving motor loads as specifically recommended by motor or equipment manufacturer or in the range of 150% to 175% of motor nameplate rating per NEC in accordance to the type of motor. **Fuse installation shall only be allowed by approval of Engineer.**

C. Interrupting Rating: 300,000 RMS Amps.

D. Maintenance Stock, Fuses:

1. Furnish the following:
    a. Minimum three spare fuses or 10%, whichever is greater, of each size and type for a spare set.
    b. Furnish spare fuse cabinet sized to contain required spare fuse stock.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install fuses where indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, national and local codes, regulations, and requirements.

B. Provide quantity of spare fuses and fuse cabinet per the requirement of this Section at the location per drawing or the direction of Owner's Representative, in addition to replace blown or defective fuses during installation, startup, system commissioning and acceptance.

C. Furnish equipment list with fuses required for all equipment using fuses.

D. Provide spare control fuses for all equipment and gear furnished.

END OF SECTION 26 28 13 0028 10 0028 13

Task	Specification	Specification Description
26 28 13 00	26 00 00 00	Electrical Demolition

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SECTION 26 28 16 00 - DISCONNECT SWITCHES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Disconnect switches, fusible and non-fusible.

B. Enclosures.

1.02 REFERENCES

A. Federal Spec. W-S-865 - Switch, Box (Enclosed), Surface-Mounted.

B. NEMA KS 1 - Enclosed Switches.

C. NFPA 70 - National Electrical Code

D. NFPA 70E - Electrical Safety Requirement for Employee Workplaces

E. UL 98 - Enclosed Switches.

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to General Requirements for submittal requirement.

B. Submit manufacturer's product data. Submit dimensioned drawings and equipment ratings for voltage, capacity, horsepower, and short circuit.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver switches individually wrapped in factory-fabricated water-resistant type containers.

B. Handle switches carefully to avoid damage to material components, enclosure and finish. Damaged switches shall not be installed on project.

C. Store switches in a clean and dry space and protected from weather.

PART 2 PRODUCTS

2.01 FABRICATED SWITCHES

A. NEMA KS 1; Type HD quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Handle lockable in ON position for service entrance disconnect. Provide defeater so that qualified personnel can open door while switch is in the closed position.

B. Use switches that have number of poles required as per drawings.

C. Switches shall be Underwriters' approved for duty shown and enclosure type per drawings. NEMA 3R switches shall be provided where exposed to weather. NEMA 3R switches shall have weatherproof threaded hubs for all conduit entries into switch.

D. Use fuse clips that are rejecting type to accept Class RK or L fuses only.

E. Identify switches, as to equipment served, with engraved laminated plastic plates. Refer to 26 05 53 Electrical Identification Section of this specification.

F. Voltage rating: 240VAC or 600VAC as per drawings.

PART 3 EXECUTION

3.01 INSPECTION

A. Contractor shall examine the areas and conditions under which safety and disconnect switches are to be installed and notify The University in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SAFETY AND DISCONNECT SWITCHES

A. Install safety or disconnect switches, where required by NEC, where indicated on drawings, and where required by equipment manufacturer, in a location convenient for maintenance on switch and adjacent equipment.

B. For equipment with motors larger than 1/8 hp, install thermally protected disconnect switches at motor.

C. Provide fused disconnect switches, whether or not indicated on drawings, when required to maintain equipment manufacturer’s warranty. Coordinate with Division 23 for warranty requirements of equipment approved by submittal.

D. Install fuses in fusible disconnect switches. Provide permanent marking inside switch enclosure for fuse type.

E. Wall mount switches, where possible, or mount on unistrut supports.

END OF SECTION 26 28 16 0028 10 00a28 16

Task	Specification	Specification Description
26 28 16 00	26 00 00 00	Electrical Demolition

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SECTION 26 29 13 13 - VARIABLE SPEED DRIVES

PART 1 GENERAL

1.01 This specification shall apply to variable speed drives installed in UTHSCSA campuses.

1.02 SECTION INCLUDES

A. Variable Speed Drives

1.03 RELATED SECTIONS

A. UT Spec Section 23 05 13 – Motors

1.04 REFERENCES

A. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings (latest edition)
B. AFBMA 11 – Load Rating and Fatigue Life for Roller Bearings (latest edition)
C. AMCA 99 – Standards Handbook (latest edition)
D. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes (latest edition)
E. AMCA 300 – Test Code for Sound Rating Air Moving Devices (latest edition)
F. AMCA 301 – Method of Publishing Sound Ratings for Air Moving Devices (latest edition)
G. NEMA MG-1 – Motors and Generators (latest edition)
H. NFPA 70 – National Electrical Code (latest edition)
I. IEEE – 112B, 587 and 519 (latest edition)

1.05 SUBMITTALS

A. Submit under provisions of UT Spec Section 23 00 00.
B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
C. Product Data:
    1. Provide literature that indicates dimensions, weights, capacities, ratings, performance, gages and finishes of materials, and electrical characteristics and connections requirements.
    2. Submit sound power level data for casing radiation over full operating range as tested and certified per AMCA standards.
    3. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
D. Manufacturer’s Installation Instructions

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of UT Spec Section 23 00 00.
B. Maintenance Data: Include instructions for routine service, spare parts lists, and wiring diagrams.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of UT Spec Section 23 00 00.
B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
C. Store in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.09 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of The University. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer’s instructions shall be followed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB with minimum 6 pulse option
B. Toshiba with minimum 6 pulse option
C. Yaskawa Z1000 with minimum 6 pulse option
D. See UT Spec Section 23 27 26 00-2, 2.3, A, 5

Substitutions: Under provisions of UT Specs Section 23 00 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.02 GENERAL

A. Furnish and install complete Pulse Width Modulation (PWM) using variable voltage, variable frequency (VVD) speed controllers, as specified herein. All of the variable speed controllers shall be applied by one manufacturer for this project. Motors must have a “three contractor bypass” as specified herein, to allow them to run if the controller malfunctions. All safety devices shall be energized. If an equal is proposed and accepted, Contractor must include installation and start-up by manufacturer’s authorized personnel. All packages shall be factory assembled and tested.
B. The Contractor shall furnish and install Variable Speed Drive motor controllers to vary the speed of the supply, return and relief air fans and pumps as shown in the fan and pump schedules on the Drawings. One controller shall control the speed of one motor only. See schedules and Drawings for quantity of controllers required.

C. The variable speed drives shall be equipped with proper filtration devices for the distance from the motors. Refer to the drawings for distances. The exhaust fans specifically will require filtrations.

D. The variable speed drive shall produce an adjustable AC voltage and frequency output for complete motor control using solid-state technology. The VSD shall be automatically controlled by a grounded electronic (4-20 mA) control signal. The drive shall produce an output volts/Hertz pattern to produce adequate starting torque under all conditions and operate smoothly at all operating speeds on variable torque load. The VSD shall be self-contained totally enclosed in NEMA 12 ventilated cabinet and capable of operation between 0 degrees and 40 degrees Celsius.

E. VSD’s shall be ETL or UL listed. All components used on option units shall be UL listed and NEMA or IEC rated. VSD’s shall be designed to meet IEEE-587 and shall comply with all applicable provisions of the latest revision of the National Electric Code. The VSD shall comply with the IEEE-519 with respect to the line noise generation.

F. The controllers shall be suitable for use with both new and used standard, high efficiency and premium efficiency 3-phase, squirrel cage, induction motors.

G. The minimum output amperage of the VSD shall be equal to 100% or greater than the load’s FLA, as shown in the schedules. The VSD shall have an overload capacity of at least 120% for 60 seconds and 110% continuous.

H. All components shall be factory mounted and wired on a dead-front, grounded, freestanding or wall mounted enclosure arranged for top or bottom conduit entry.

I. The controller enclosure shall be provided with the manufacturer’s illustrated operating instructions and parts list mounted inside the enclosure door.

J. PWM controllers shall be designed to provide stepless motor control from 5 percent to 100 percent of the base speed.

K. 480/120 Volt control power transformer for control circuits shall have two fuses on the primary and one fuse on the secondary.

L. The VSD shall have an electronic output current overload limit, adjusted to protect the VSD. This protection shall be coordinated with the bimetallic motor overload relay provided in the bypass compartment to protect the motor in all modes.

M. The frequency of the carrier frequency for the PWM control shall be programmable to prevent resonance in the mechanical system, or other methods of controlling motor noise shall be provided. Sound enclosures over the motor are not acceptable. The VSD shall also provide a feature for excluding or jumping bands of resonant sine-coded frequencies or future control connections to add this cost at a later date.

N. The VSD shall have independently adjustable acceleration and deceleration circuits of minimum range, 5 to 120 seconds adjustable minimum and maximum speed limits. Extended time periods are also acceptable.

O. The VSD shall have user programmable auto-restart after power failure, power sure, or overcurrent. VSD shall shutdown after multiple restarts. VSD shall provide fuse-less electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause breaker or fuses to open. In case of an output ground fault or similar abnormal output condition, the VSD shall be fully operational after clearing the output fault condition and resetting the VSD.

P. The VSD must be able to start a load free-wheeling in either direction.

Q. Under all conditions the drive shall be able to withstand the opening or closing of a disconnect on the drive output without damage.

R. All control adjustments shall be made without the necessity of an extender board or specialized meters, but rather from front access controls.

S. Low voltage logic and 120V control circuits shall be physically isolated from the 480V power circuits. Signal circuit commons shall be grounded at the receiving end.

T. The VSD shall include a power ride-through feature to allow continuous operation through up to a three cycle line loss.

U. The drive shall not be phase sequence sensitive.

V. Components shall be pretested and each complete VSD shall have a full load factory burn-in and electronic overload test.

W. The VSD shall provide the following minimum performance:
   1. Minimum of .95 efficiency, at all speeds.
   2. Minimum of .95 displacement power factor and .85 true power factor at all speeds.

2.03 FEATURES

A. The VSD shall incorporate the following minimum features:
   1. Input power: 460 V/3 phase/60 Hz.
   2. Input circuit breaker
   3. Input line filter capable of protection the electronics against transient voltage spikes or notches, as well as back-feed of RF (Radio Frequency) interference, into the incoming power supply.
   4. Fuse-less electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause fuses to open.

B. The following door mounted devices:
   1. “Power on” light
   2. Hand/off/auto (or equivalent) selector switch
   3. Manual speed control during operation
   4. Inverter/Bypass mode selector switch
   5. Digital display unit
   6. Status, frequency/percent speed and fault diagnostics
   7. Door interlocked Main Input Disconnect Switch, lockable in the off position

C. The Cabinet shall contain group terminals for control signals:
   1. Input electronic signal, Process Feedback to control speed.
   2. Output electronic signal to report frequency.
   3. Output contact to open on VSD Fault, Motor Overload, or External/Life Safety shutdown.
   4. Start-Stop
   5. Input contact to open for External/Life Safety shutdowns.

D. The Drive Package must be capable of External/Life Safety shutdown whether in the drive or in the bypass mode.

E. If the VSD manufacturer recommends, the cabinet shall contain a Test selector switch to facilitate static testing of the drive at startup or while the motor operates in the bypass mode. This switch should be mounted inside the cabinet for technician access.

2.04 DISCONNECT AND INTERFACE

A. The following shall be mounted within the enclosure:

1. Line, load and bypass contactors capable of interrupting the locked rotor rating of the driven motor. Bypass and load contactors must be mechanically interlocked to prevent simultaneous closure.
2. Overload relay
3. A dedicated terminal strip to allow the controller to be interconnected with external shutdown contacts from smoke detectors, fire detectors, damper interlocks, freeze-stats, time clocks, remote master on-off switch, energy management and control system (FCMS) and input signals. The system must be capable of shutdown whether in the drive or in the bypass mode by remote detectors.
4. Input Circuit Breaker

2.05 FAULT DETECTION DEVICES

A. A diagnostic display center visible from outside the Package Cabinet, providing an indication of the VSD's output frequency and the following operating and fault conditions:
   1. Output current value, Amps
   2. Output frequency, Hertz
   3. Inverter status and mode
   4. Programmable internal set-points and limits
   5. Overheating fault
   6. Low AC line voltage
   7. Current overload
   8. High DC bus voltage
   9. VSD output fault
   10. Capacitor charge status

B. The VSD shall incorporate the following Protective Features:
   1. Instantaneous overcurrent trip
   2. Unit over temperature protection
   3. High DC bus voltage, 800 VDC
   4. Low input voltage, 15% or recommended value per manufacturer
   5. DC bus fuse protection
   6. Input surge protection, MOV, or hybrid TSS circuit
   7. Ground fault protection
   8. Phase to phase fault protection

2.06 CONTROL

A. All control adjustments shall be made through the interface

B. Low voltage lotic and 115V control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded at the VSD only.

C. The VSD shall include a power ride-through feature to allow continuous operation through up to a three to five cycle line loss.

D. Electronic output overload protection shall be provided. The drive shall not be phase sequence sensitive.

E. The VSD shall have independently adjustable acceleration and deceleration circuits of 5 to 120 seconds. Extended time periods are also acceptable.

F. The VSD shall have full function output current limit adjustable from 10 to 100 percent.

2.07 SYSTEM OPERATION

A. All safety devices shall operate in all modes of operation. Two switches shall be mounted on the Package Cabinet door: a two position Inverter/Bypass switch and a three position Hand/Off/Auto (or equivalent) switch. Six modes of operation will be defined by the Inverter/Bypass and Hand/Off/Auto Selector switches.

B. **"Inverter selected with HOA in Off" Mode** - all contractors open, VSD 480 Volt power off, all 120 Volt and VSD Control Power on, motor will not operate.

C. **"Inverter selected with HOA in Hand" Mode** - Run contactors closed, VSD varies motors speed per setting of the manual speed control at VSD.

D. **"Inverter selected with HOA in Auto" Mode** – Run contactors operate per external start-stop signal, VSD varies motor speed per signal from the PI Controller. (The PI Controller combines a Process Feedback Sensor control signal with a Set-point Reset control signal to achieve an externally controlled motor speed around a remotely resettable process value.)

E. **"Bypass selected with HOA in Off" Mode** - all contactors open, VSD 480 Volt power off, all 120 Volt and VSD Control Power on, motor will not operate.

F. **"Bypass selected with HOA in Hand" Mode** – Bypass contactor closed, VSD 480 Volt power off, all 120 Volt and VSD Control Power on, motor operates at full speed.

G. **"Bypass selected with HOA in Auto" Mode** – Bypass contactors closed, VSD 480 Volt power off, all 120 Volt and VSD Control Power on, motor operates at full speed with start-stops controlled by external start-stop signal.

PART 3 EXECUTION

3.01 As part of the purchase price and agreement, a full, unconditional, one (1) year warranty on all parts and labor shall be provided. The warranty shall include all parts, labor, shipping, field service or technician time, labor or travel expenses and verbal or written correspondence with the VSD manufacturer or his representatives, included that which might be incidental to the proper installation and operation of the equipment.

3.02 The manufacturer's representative shall provide a list of recommended spare parts.

3.03 The manufacturer's representative shall provide terminal block to terminal block wiring diagrams coordinated with The University to provide a complete and functional operating system. Furnish detailed drawings showing construction, dimensions, wiring diagrams and installation procedures for engineer's approval.

3.04 The manufacturer shall provide a factory trained technician to start the VSD and place it into operation.

3.05 The successful vendor shall provide for and present to The University, at no cost to The University, a training and troubleshooting course at The University's location. This course shall be comprised of a minimum of two (2) days of classroom instruction for a minimum of four (4) hours per day complete with visual aids, documentation, circuit diagrams and hands-on training for a group of approximately 6 people.

This course is not to be construed as a sales meeting, but rather as a school to familiarize The University with the care, troubleshooting and servicing of the VSD.

3.06 VSD's shall be wall hung units. Contractor shall provide uni-strut mounting bracket for drives. Contractor shall reinforce the wall studs with bracing as required to adequately support the drive. Installation of the VSD shall allow for clearance in front of the drive as required by the latest revision of the National Electric Code for an electrical panel.

END OF SECTION 26 29 13 13

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Task	Specification	Specification Description
26 29 13 13	01 22 16 00	No Specification Required
26 29 13 13	23 05 13 00	Electrical Renovation

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SECTION 26 31 00 00 - PHOTOVOLTAIC POWER SYSTEM GRID CONNECTED

PART 1 - GENERAL

1.01 SUMMARY

A. Description of Work: This section describes in general the work required to furnish and install a complete, operational grid connected photovoltaic power system.

B. The intent of this portion of the specifications and drawings is a complete, operational roof-mounted solar photovoltaic array and all balance of system components for the building and Carport. The system shall include, but not be limited to:

1. Photovoltaic panels, modules and arrays.
2. Array supporting structures.
3. Interconnect wiring, disconnecting means and overcurrent protection.
4. UL listed grid-connect inverter systems.
5. Ancillary metering, monitoring software and display software.

1.02 DESIGN AND CONSTRUCTION REQUIREMENTS

C. The Contractor will be required to provide a turn-key photovoltaic power system based on the components used in the basis of design included herein. The contractor is not limited to design the proposed system using those specific components used to provide a basis of design; however, the Contractor will be required to demonstrate that the system will perform in accordance with these specifications. That demonstration will be in the form of a submittal indicating the projected energy production of the proposed system over a period of a year using generally available TMY3 meteorological files for San Antonio, Texas and a generally accepted solar simulation program. Examples of acceptable programs include, but are not limited to PVSYST and PV Design Studio. The required energy production including accounts for losses for the Rooftop system is 159 MWh/year based on a ten degree module slope and seven degree inclination of the module racks. The required energy production of the carport system is 82 MWh/year based on a ten degree module slope. The minimum specific production of each system shall be a minimum of 1450 kWh/kWp per year.

1.03 DESIGN AND CONSTRUCTION CONSTRAINTS

D. The Contractor will be required to design rooftop systems that accommodate roof mounted equipment such as vents and fans that are currently designed for the building. Copies of drawings showing the roof mounted equipment can be obtained from the existing general contractor. Roof mounted module framework will be required to be mounted on vertical stub columns that extend through the roof of the building. The height of the array shall be limited to 5”-6” above the roof deck (See Architectural attachments). Additional structural support members will be required to span the stub columns and shall be furnished by the contractor to support the module framework. A Structural Engineer’s seal will be required on the structural drawing submittal.

1.04 QUALITY ASSURANCE AND REFERENCE STANDARD

E. Codes and Standards:

1. NFPA 70-2008 National Electrical Code. (latest edition)

2. IEEE 929, P929, 928, 1262, P1373, P1374.

3. UL 1741 Std. For Static Inverters & Charge Controllers.

4. IEEE 519.

5. ASTM E1036-B5.

6. IEC 61215, TC-82.

F. Related Work: This section is a Division 26 Specification and as such will be taken as an integral part of all other Divisions 26 sections, including Section 26 05 00, “Materials and Methods”.

1.05 SUBMITTALS

G. Submit manufacturer’s drawings and data demonstrating compliance with these specifications and the drawings. Information shall include, but not be limited to:

1. Simulated Annual Power Production Data for Carport and Rooftop systems

2. Photovoltaic modules.

3. Inverter systems.

4. Terminals and terminal blocks.

5. DC rated circuit breakers and fusing.

6. Operating and Maintenance Manuals.

7. Combiner Boxes and Fusing.

8. Modular Support Structures.

9. System Mounting Hardware.

10. Metering Hardware and software.

11. Sealed Structural Primary Support Drawings

PART 2 - PRODUCTS

2.01 MATERIALS AND WORKMANSHIP

A. Materials, equipment and parts comprising the units specified herein shall be new and unused, of current manufacture, of highest grade, and assembled in a workmanlike manner.

2.02 MANUFACTURER

A. All photovoltaic system components and all major items of auxiliary equipment shall be manufactured by manufacturers regularly engaged in the manufacture of photovoltaic system components. Each component shall be factory assembled and tested by the manufacturer. Delivery, parts, service and warranty shall be furnished by the manufacturer or an authorized dealer within 300 miles of the project. Refer to other sections of this specification for compliance with the Buy American Act requirements. Acceptable manufacturers of system components shall be:

1. BP Solar.

2. Cutler Hammer.
3. Gould Shawmut.
4. Littlefuse.
5. Square D.
6. Trace Technologies (Xantrex).
7. Sharp.
8. SMA
9. Suntech
10. Amtec Solar.
11. UniRac Solar Mounting Systems.
12. Schott Solar
13. Satcon
14. PV Powered
15. Solar World
16. Tyco
17. Sunlink

B. Acceptable manufacturers of solar data logging, metering and display systems:

1. Watts Up
2. Fat Spaniel Technologies
3. Xantrex
4. Draker Solar Design
5. Eaton
6. or Approved Equal.

2.03 WARRANTY

A. Equipment furnished under this section shall be warranted against defective parts and workmanship as outlined under Division 1 and in accordance with the terms of the manufacturer’s and dealer’s standard warranty for a period of no less than five years. Solar collector panels shall have a manufacturer’s limited warranty for power output of 25 years.

2.04 STARTUP AND TRAINING

A. Upon completion of the installation, the contractor shall perform startup by a factory trained and authorized dealer service representative. Contractor shall supply maintenance and instruction books to The University during startup and demonstration. In addition, the Contractor shall furnish training in the amount of 8 hours to The University on startup, operation, maintenance and troubleshooting of the complete system. See Paragraph 3.2.

2.05 PHOTOVOLTAIC MODULES (Basis of Design)

A. Photovoltaic modules shall consist of multicrystalline silicon laminated between sheets of ethylene vinyl acetate (EVA) and high transmissivity low-iron tempered glass. Each module shall be assembled in an extruded and anodized aluminum frame and shall include bypass diodes. Each module shall include TWO IP54 rated raintight junction boxes for wiring connections to system panels and the array. Nominal performance characteristics per module shall be:

Roof Mount:

Maximum Power (P_{max})	270W nominal
Voltage at P_{max} (V_{mp})	30.3V
Current at P_{max} (I_{mp})	7.6A
Short Circuit Current (I_{sc})	8.24A
Open Circuit Voltage (V_{oc})	37.0V
Nominal Size	1640 mm x 994 mm

Carport Mount:

Maximum Power (P_{max})	208W nominal
Voltage at P_{max} (V_{mp})	28.5V
Current at P_{max} (I_{mp})	7.3A
Short Circuit Current (I_{sc})	8.13A
Open Circuit Voltage (V_{oc})	36.1V
Nominal Size	1640 mm x 994 mm

2.06 POWER CONVERSION INVERTER SYSTEM

A. The photovoltaic system inverter assembly shall be designed to output 480V three phase ac power. The inverter assembly shall incorporate insulated gate bipolar transistor based power electronics to convert nominal 300-660V DC input to a pulse width modulated 480V three phase output. The inverter shall contain an integrated operator interface for access to metering, status and control functions. In addition, the inverter shall have the following salient performance characteristics and features:

IGBT Device protection:	DC Overvoltage, Overtemp, Overcurrent
Utility Islanding Protection	In accordance with UL 1741 and IEEE 928/929
Full Load Efficiency	>96%
Nominal Line Frequency	60Hz
Line Voltage	480VAC Nominal, 3 Phase, +6%, -12%
Power Factor	Unity +/- 0.02
AC Current Distortion	IEEE 519 compliant, <5%
PV Array Configuration	Neg. Grounded with Monopole or Bipolar Available
Max V_{oc}	660VDC
Ripple Current, Full Load	1.6A rms (5%)
Interface	Serial RS 485
Display	LCD Backlit 4-line X 20 Character
User Settable Parameters	PV start voltage, PV shutdown power

Protective Functions	AC Over/Under: voltage, current and frequency Inverter Overtemperature Active anti-islanding DC Overvoltage
Manual stop	Manual Emergency stop pushbutton
Ambient Temperature	-20 - +50 Deg C.
Relative Humidity	95% Non Condensing
Elevation	to 6600 feet without derating
Enclosure	NEMA 4
Cooling	Fan Forced
Remote Alarming	Integral or external Form C contacts to indicate fault at the inverter

2.07 INVERTER FAULT REPORTING

A. The inverter system shall provide remote indication of an inverter fault condition to the building BAS system. The reporting shall occur through the use of Form C contacts integral to the inverter, or provided in supplementary relays. Contractor shall coordinate the programming of additional BAS points necessary to indicate the inverter faults on the BAS system.

2.08 COMBINER BOXES AND FUSED COMBINERS

A. Combiner Boxes shall be UL1741 listed and contain integral finger safe fusing. Enclosures shall be NEMA 4X. The combiner shall be rated for use on 1000VDC systems. Basis of design shall be Amtec Solar, Prominence Series.

2.09 TERMINALS

A. Only W-listed terminals shall be used where connections are required and connector blocks are not furnished with a component. Only heavy-duty die crimpers shall be used for crimping connections. Unlisted electronics or automotive grade terminals will not be permitted.

2.10 MOUNTING RAIL SYSTEM

A. Module mounting structure shall consist of a modular extended aluminum system consisting of rails and mounting hardware engineered to meet ASCE7-05 design wind loading for hurricane prone regions. Acceptable frame systems and procedures are Unirac Solar Mount installed in accordance with the Sun Frame Code compliant Installation Manual 809. Installer must demonstrate compliance with this installation guideline and wind load criteria. The rail design must be prepared by a Structural Engineer Licensed in the State of Texas.

2.11 MONITORING AND DISPLAY SYSTEM

A. The PV contractor/system integrator will be required to provide a display and monitoring system that provides for real time display of the array operating parameters as well as historical data. The system shall consist of the following components as a minimum:

1. A Graphic Flat Screen display unit will be provided by The University that will display information logged by the software provided and programmed by the systems integrator-contractor.

2. Rough-in conduit systems to provide for interconnecting wiring to The University furnished LAN switch, server and display equipment.

3. Wiring, gateways and hardware interfaces necessary to provide for connection to owner’s LAN switch.

4. Software package that provides for the retrieval and display of historical data and display of real time parameters of the PV system.

B. Integration and Data Logging Software shall be capable of providing definable graphics that allow for displaying of real time power output on AC and DC sides and trending information on each array output as well as capability to indicate system alarms. The software shall be IP based and shall allow for web-based monitoring of the PV systems. The contractor shall provide the software for installation on The University's server. Data logging shall include a minimum storage capacity of five years of accumulated data. Displayed data shall be graphically indicated using easily interpreted meters or graphs. As a minimum, the following information shall be displayed:

1. Solar Irradiance in real time
2. Outdoor Air Temperature in real time
3. Wind in real time
4. Array Cell temperature in real time
5. Power Production in real time in W/m^2 and peak watts
6. Historical Data including cumulative energy production in kWh and kWh/m^2 for Today, This Month, This Year and Total since installed.
7. Cumulative Environmental Benefits to include estimated values for CO_2, NO_x, and SO_x avoided.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General Requirements: Install all system components in strict compliance with the Latest Editions of NEC and in accordance with recommended practices as outlined in SAND96-2797 incorporated herein by reference.

B. All system wiring is required to be installed in conduit in accordance with Section 26 05 33 including roof mounted conductors.

C. At all panel (single and multiple module) connections, a terminal bar or busbar connection is required to allow the selective disconnecting of any module or panel. Multiple wire splices or daisy chaining will not be permitted even if indicated schematically on the drawings

D. Use only 1000VDC rated fuses, circuit breakers, terminal blocks, disconnects and other components on the PV system.

E. Use of other than type XHHW-2, RHW-2 conductors or cabling specifically designed for use on solar PV systems is not permitted without the consultation of the Engineer.

F. Voltage drop shall be limited on all conductors such that DC side power is available under all conditions that the PV array is producing sufficient voltage to turn the inverter on, but in no case shall be more than 2%.

G. Contractor shall provide a minimum of one and a maximum of three spare fuses for all fuse types used in any capacity on the Photovoltaic System.

H. Provide any manufacturer software that is specific to the inverters and for monitoring the inverters to UTHSCSA facilities for installation on personal computers designated by the UTHSCSA.

3.02 COMMISSIONING AND TRAINING

A. The PV integrator shall perform system startup and commissioning on the completed system. As a minimum, the contractor shall verify the installation by performing a Megger test on each Homerun, measuring The Voc on each string and perform the startup sequence in accordance with the inverter manufacturer’s instructions. Following startup, measurements of Imp for each string shall be performed.

B. Performance verification shall include measurement of cell temperature, irradiance and inverter AC output. The output shall be compared to the predicted performance of the system in order to verify that the system is performing as designed.

C. The PV integrator shall provide a minimum of eight hours of instruction and training on the PV system to The University. Training shall include a physical walkthrough of all installed components, Training on the operation, maintenance and safety related features and procedures for the system shall be included as a part of the system training.

END OF SECTION 26 31 00 00

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Task	Specification	Specification Description
26 31 00 00	01 22 16 00	No Specification Required
26 50 00 00	26 00 00 00	Electrical Demolition

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SECTION 26 51 00 00 - INTERIOR AND EXTERIOR LIGHTING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Interior lighting fixtures and accessories

B. Exterior lighting fixtures and accessories

C. Emergency lighting units

D. Emergency exit signs

E. Emergency fluorescent lamp power supplies

F. Lamps

G. Ballasts

H. Site lighting poles

I. Lighting controls

1.02 REFERENCES

A. NEPA 101 - Code for Safety to Life from Fire in Buildings and Structures

B. NEMA WD1 - General-Purpose Wiring Devices

C. ANSI C82.1 - Specification for Fluorescent Lamp Ballasts

D. ANSI C82.4 - Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type)

E. NEMA LE - H-I-D Lighting System Noise Criterion (LS-NC) Ratings

F. UL 844 - Electric Lighting Fixtures for Use in hazardous (classified) Locations

G. UL 924 - Emergency Lighting and Power Equipment

H. UL 935 - Fluorescent-Lamp Ballasts

I. UL 1029 - High-Intensity-Discharge Lamp Ballasts

J. UL 1572 - High Intensity Discharge Lighting Fixtures

K. UL 1574 – Track Lighting Systems

L. IESNA – Lighting Handbook

M. NEMA WD 1 - General Color Requirements for Wiring devices

N. NEMA LE 5B – Procedure for Determine Luminaire Efficacy Ratings for High-Intensity Discharge Industrial Luminaires

O. NFPA 70 – National Electrical Code

P. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

Q. Standards For State-Funded Outdoor Lighting Fixture – Texas House Bill 916 (1999)

R. UT System OFPC – Security Planning and Design Guidelines (2003 release)

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00.UT, Basic Electrical Requirements, and Division 1 for submittal requirement.

B. Submit manufacturer's data on interior and exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by luminaire "type" in alphabetical order, with the proposed fixture and accessories clearly labeled.

C. Submit dimensioned drawings and performance data including complete photometric test data for each luminaire, candlepower distribution curves in two or more planes, candlepower chart zero to 90 degrees, lumen output zonal summary chart, average and maximum brightness data, and coefficients of utilization for zonal cavity calculations, , spacing to mounting height ration, efficiency and visual comfort probability. Also provide luminaire weights, mounting data, and accessory information for each luminaries type.

D. Lamps: Catalog cuts showing voltages, colors, approximate hours life, approximate initial lumens, lumen maintenance curve, lamp type and base.

E. Ballasts: Catalog cuts showing type, wiring diagram, nominal watts, input voltage, starting current, input watts, sound rating, power factor and low temperature characteristics.

F. Site lighting pole data and catalog cuts, including wind loading, complete dimensions and finish.

G. Shop drawings for site lighting luminaries showing pertinent physical characteristics, including fastening details, ballast type and location.

H. Controls: Catalog cuts and/or shop drawings showing dimensions, voltage capacity, contact ratings, wiring diagrams, operating levels, and temperature ratings.

I. Lighting design shall be in compliance with power allowance for lighting, which is stipulated by ASHRAE 90.1. Compliance forms along with engineering data associated with it shall be submitted for Owner’s review during design phase.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver lighting fixtures individually wrapped in factory-fabricated fiberboard type containers. Parabolic louvers shall be shipped in thermally sealed polyethylene wrapper.

B. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.

C. Store lighting fixtures in a clean, dry space and protected from the weather.

PART 2 – PRODUCTS

2.01 GENERAL

A. Lighting fixtures and accessories shall comply with the design and function requirements of the project. Design characteristics shall be as noted in manufacturer's submittal data.

B. Provide lighting fixtures of the size, type and rating as scheduled, complete with, but not limited to, lamps, lamp holders, reflectors, ballasts, poles and wiring.

2.02 INTERIOR LIGHTING FIXTURES

A. Fluorescent Fixtures

1. Lenses shall be UV stabilized, injection-molded, clear, 0.150- inch minimum thickness virgin acrylic. Provide a minimum of 8 hold-down lens retaining clips for troffers utilizing framed diffuser lenses.
2. Parabolic aluminum louvers shall be semi-specular, low-iridescence finish silver anodized aluminum, 2 or 3 inches deep as per drawings. Louvers shall be roll formed with roll grain horizontal to view plane. Louver intersections shall be of a close-fitting, tab-and-slot construction permitting no light leaks.
3. Parabolic plastic louvers shall be vacuum-metalized polystyrene with specular finish and antistatic properties.
4. Lighting fixture door frames shall be flush steel hinged and equipped with rotary-action cam latches.
5. Lighting fixture housing shall be minimum 22-guage, cold-rolled steel with pre-punched knockouts and access plate for electrical connections. End plates shall be minimum 20-guage with pre-punched hanger holes. Ballast mounts shall be separated for heat dissipation.

6. Three lamp luminaries for dual level switching shall have outer two lamps on one ballast, inner lamp on second ballast, shared with adjacent luminaire's inner lamp if practical.

B. Incandescent fixtures shall not be used.

C. Lighting track shall be surface mount or pendant mount per the requirement on drawings, by manufacturer of track mounted light fixtures.

D. High Bay, Low Bay HID Fixtures

1. Provide rugged, lightweight, cast aluminum ballast housing with a baked electro-coat paint finish.

2. Optic reflector shall be fully fluted, anodized aluminum providing high efficiency. Where enclosed and gasketed type fixtures are specified, provide luminairs designed for continuous operation in an ambient temperature of 55° C.

E. Lamp Holders or Sockets

1. Incandescent lamp holders shall be screw base and have porcelain insulating shells and be rated for heavy duty, 660W.

2. Fluorescent Sockets: Fluorescent lamp holders shall be heat-resistant porcelain or plastic, designed and rated for the lamp type specified. Lamp holders shall be designed to maintain solid electrical contact at all times. The detent position for bi-pin lamp holders shall be a positive lock so that mechanical effort shall be required to rotate the lamps. Lamp holder shall be specifically compatible with lamping.

3. HID Medium and Mogul Base Sockets: Provide glazed porcelain pulse-rated heavy duty sockets with silicone leads hard soldered to nickel plated brass screw shell. Lamp holders shall also employ a positive spring locking means to maintain good electrical contact at the center terminal of the lamp.

4. Lamp holders and sockets shall be provided with minimum 18 AWG wiring leads.

F. Reflector Finishes

1. Painted Finishes: Provide electro-statically applied dry polyester white powder coat finish with minimum reflectance of 88 percent on all light reflecting surfaces.

2. Specular/Semispecular Finishes: Provide Alzak-type anodized finish on aluminum louvers and reflectors as specified in Luminaire Schedule as shown on the drawings. Minimum reflectivity shall be:

   a. Specular: 80 percent

   b. Semi-specular: 75 percent

G. UL Listing

1. All Luminaries and components shall be UL tested, listed, and labeled.

2. Luminaries installed under canopies, roofs, or similar damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.

3. Recessed luminaries installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall be approved for the installation in a fire-rated ceiling.

2.03 EXTERIOR LIGHTING FIXTURES

A. Enclosures shall be complete with gaskets to form weatherproof seal and UL approved for wet locations.

B. Provide low temperature ballasts with reliable starting to 0 degrees F.

2.04 BATTERY BACKED EMERGENCY LIGHTING UNITS

A. Acceptable Manufacturers

1. Dual Lite

2. Lithonia

3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 16010, and Division 1 for substitution requirement.

B General Requirements

1. Provide emergency lighting units self-contained complete with batteries, charger, and lamps to provide automatic emergency lighting upon failure of normal power. Battery fixtures shall not be used unless called for on drawings.
2. Battery shall be 6 or 12 volts, sealed maintenance free, nickel cadmium type, 24-watt rated capacity, with 1.5 hours minimum capacity to supply the connected lamp load.
3. Charger shall be solid state capable of maintaining the battery fully charged during normal conditions, and capable of recharging discharged battery to full charged within 24 hours.
4. Lamps shall be 12 watt minimum, sealed beam Tungsten Halogen type.
5. Unit housing shall be thermoplastic or steel with beigefinish.
6. Indicators: Provide lamps to indicate AC ON and RECHARGING.
7. Provide test switch to manually transfer unit from normal supply to battery supply.
8. Unit shall be 120 or 277 volt. As per drawings.

2.05 EXIT SIGNS

A. Acceptable Manufacturers

1. Dual Lite
2. Lithonia
3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 16010, and Division 1 for substitution requirement.

B. General Requirements

1. Provide red LED with red diffuser exit signs at the locations per drawings. Exit signs shall have stencil face, 6-inch high red letters on white background, or as specified otherwise, with red Chevron type directional arrows as indicated on drawings.
2. Battery backed exit signs shall be provided with integral battery-operated emergency power supply, including power failure relay, test switch, AC ON pilot light, battery, and fully-automatic charger. Provide test switch to manually transfer unit from normal supply to battery supply. Battery fixtures shall not be used unless called for on drawings
3. Battery shall be sealed maintenance free, nickel cadmium type, 6 or 12 volts, 24-watt rated capacity, with 1.5 hour minimum capacity to supply connected lamp load. Battery fixtures shall not be used unless called for on drawings
4. Unit shall be 120 or 277 volt. As per drawings.

2.06 LAMPS

A. Acceptable Manufacturers

1. General Electric Company
2. Philip Lighting Company
3. Sylvania
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 16010, and Division 1 for substitution requirement.

B. General Requirements

1. Lamps including linear fluorescent, compact fluorescent, and HID shall be low mercury type and shall pass all federal TCLP (Toxicity Characteristic Leaching Procedure) test requirements in effect at the time of manufacture. All lamps shall be energy saving and rapid or program start type.
2. Linear fluorescent lamps shall be T8 lamps. Compact lamps shall be twin or double twin tubes. All lamps for one project shall be provided by the same manufacturer with color temperature as indicated on drawings. Operation voltage and wattage shall be as indicated on drawings. No U-tube lamps are acceptable.
3. Mercury vapor HID lamps shall not be used.
4. Metal halide HID lamps shall be phosphor coated, suitable for the burning position required, and pulse start.
5. High-pressure sodium HID lamps shall be clear or diffuse coated.
6. Maintenance Stock: Furnish a stock of replacement lamps in the original cartons or packing sleeves, amounting to 10% (but not less than two lamps in each case) of each type and size lamp used in each fixture type. Deliver replacement stock as directed to Owner's storage space.

2.07 BALLASTS

A. Acceptable Manufacturers

1. Advance
2. General Electric
3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 16010, and Division 1 for substitution requirement.

B. General Requirements

All ballasts shall be UL listed and have the UL symbol on the label.

1. Ballasts for fluorescent lamps
    a. Provide MVOLT ballasts for all operations except for under-counter fixtures that shall be rated for 120V operation. Ballasts shall be electronic type, rapid start, and power factor of 95 percent or greater, suitable to operate at 60 Hz input frequency.
    b. Electronic ballasts shall comply with all FCC and NEMA limits governing EMI and RFI, and shall have Total Harmonic Distortion (THD) of less than 10 percent.
    c. Ballasts shall be Class P thermally protected.
    d. Sound level criteria
        1) Nominal 430 mA Lamps: Class A sound rated.
        2) Nominal 800 mA Lamps: Class B sound rated.
        3) Nominal 1500 mA Lamps: Class D sound rated. Provide isolation mounting and insulation to reduce sound transmission and radiation.
    e. Electronic Dimming Ballasts: Compatible with lamp and dimming system, labeled for use and listed as compatible by dimmer manufacturer with a minimum full-to-20 percent dimming range.
    f. Exterior Fluorescent Ballasts: Provide zero degree starting rating.
2. Ballasts for HID lamps
    a. HID ballast shall be multi-tap encased and potted thermally protected high power factor of 90 percent or greater, constant wattage regulating, and autotransformer type. Ballast ambient operating temperature range shall be -20 to +130 degrees F. Ballasts shall be compatible to the lamps chosen for specific burning position, and compensate for the loss in efficiency.

b. Provide isolation mounting and insulation of HID ballasts to reduce sound transmission or radiation.

c. Each HID ballast shall have a fast acting primary inline fuse built into the fixture assembly by the manufacturer.

2.08 LIGHTING POLES

A. Lighting poles shall be metal, type and finish as specified in Luminaire Schedule as shown on the drawings.

B. Site lighting poles shall meet wind load rating requirements per local building code.

C. Pole foundation shall be design by A/E. Refer to pole base details as shown on the drawings for specific pole base requirements.

D. The entire pole assembly shall be designed to withstand a steady wind load rating requirements per local building code and a gust factor of 1.3 without permanent deflection.

E. Anchor bolts shall be fabricated from commercial quality hot rolled carbon steel bar with guaranteed minimum yield strength of 55,000 psi. Bolts shall have an "L" bend on one end and be galvanized a minimum of 12" on the tread end. Furnish four bolts and bolt setting template with each set of anchor bolts. Furnish one hex nut, 2 hardened steel washers, and one hex nut with a stainless steel locking pin with each bolt. Furnish two leveling shims with each anchor bolt set.

F. Standard finish for pole and accessories shall be a factory applied polyester thermosetting powder coating electro-statically applied to the surface of the substrate to a minimum thickness of 3 mil. Color as specified.

G. Provide and install pole base covers on all poles. Each pole to have internal grounding lug and ground rod.

2.09 LIGHTING CONTROL

A. Refer to Section 26 27 26.UT Wiring Devices and Floor Boxes for lighting switch, dimming control, and occupancy sensor.

B. Photocell shall be automatic dawn on, dusk off switching; moisture, temperature, and vibration-resistant die-cast aluminum housing; time delay feature to prevent false switching; field adjustable to control operating levels.

PART 3 - EXECUTION

3.01 INSPECTION

A. Prior to order lighting fixture, check the building electrical system requirements, architectural finishes, and the type of ceilings that lighting fixture will be installed. Any discrepancies of compatibility pertaining trim, frames, color, mounting, ballast, voltage and etc. shall be brought to the attention of A/E by written notice. Do not proceed with procurement until discrepancies are resolved in a satisfactory manner.

B. Installer shall examine the areas and conditions that light fixtures are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF LIGHTING FIXTURES

A. Install light fixtures in accordance with the manufacturer's written instructions, the applicable requirements of NEC and national and local code, standard, and regulations. Install lamps in accordance with manufacturer's instructions.

B. Install luminaries at locations as shown on the Drawings; install aligned, aimed, and leveled. Install fixtures in accordance with manufacturer's installation instructions complete with mounting accessories, trim and support materials. Fasten fixtures securely to structural support members of the building; solid pendant fixtures shall be plumb.

C. Coordinate with other crafts to avoid conflicts between luminaires, supports, fittings and mechanical equipment.

D. Surface Mounted Fluorescent Fixture:

   1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of fixtures.

   2. Where ceiling system has not been certified to support weight of fixtures, fixtures shall be supported at four points near each corner of fixtures.

   3. Provide a minimum 5/8" air space between the fixture and the ceiling.

E. Recessed Fluorescent Fixtures:

   1. Handle specular/semi-specular louvers and down light cones using only new clean white cotton or silk gloves. Do not touch louvers or cones with bare hands. Leave luminaries clean and free of any visible dust, debris, or fingerprints with all lamps operational at time of acceptance of work.

   2. All recessed fluorescent fixtures shall be supported from building structure above ceiling with galvanized steel wire at not less than 2 points diagonally across fixture. Size of wire shall be capable of supporting weight of fixtures.

   3. Recessed luminaries trims shall fit snugly to the mounting surface and shall not exhibit light leaks or gaps. Provide feed-through junction boxes or provide separate junction boxes. All components shall be accessible through the ceiling opening.

   4. Connect recessed luminaries to junction box with flexible steel conduit and fixture wire.

F. HID Fixtures

   1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of fixtures.

G. Pole Mount Lighting

   1. Provide in-line fusing at handhole for all pole-mounted luminaries.

   2. Provide removable unitized ballast/component tray with separable connector in all pole-mounted luminaries.

   3. Construct base of concrete with dimension and depth as noted on the drawings.

   4. Install anchor bolts with minimum projection above top of bases, as specified by pole manufacturer. Ground as indicated on drawings.

   5. Mount standards on bases plumb and true utilizing shims as necessary. Grout thoroughly between base-plate and foundation using non-shrink grout.

   6. Touch up chips and scratches on poles (to match new finish) upon completion.

H. Lighting Fixtures Adjustment

   1. Adjust to illuminate intended areas as directed.

   2. Adjust exterior fixtures during hours of darkness.

I. Immediately before final observation, clean all fixtures, inside and out, including plastics and glassware, and adjust all trim to properly fit adjacent surface, replace broken or damaged parts, and lamp and test all fixtures for electrical as well as mechanical operation.

J. Protect installed fixtures from damage during the remainder of the construction period.

K. Upon completion of installation of interior lighting fixtures, and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

L. Incandescent lamps shall be new at time of final acceptance. Fluorescent lamps may be used in the final finishing of the building. Those that have exceeded more than 1/3 of their rated life (as established by Construction Inspector records), or that have blackened ends or inoperable shall be replaced with new lamps before final acceptance.

M. Lamp Disposal

  1. The procedure of disposal of lamps that are mercury containing shall follow the guideline set by EPA (definitions in Title 40 Code of Federal Regulations 261 Subpart C, January 2000).

END OF SECTION 26 51 00 00

Task	Specification	Specification Description
26 51 00 00	26 00 00 00	Electrical Demolition
26 51 13 00	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 51 13 00	26 00 00 00	Electrical Demolition
26 51 13 00	26 51 00 00	Interior and Exterior Lighting
26 52 00 00	26 00 00 00	Electrical Demolition
26 53 00 00	26 00 00 00	Electrical Demolition
26 55 00 00	26 00 00 00	Electrical Demolition
26 55 70 00	26 00 00 00	Electrical Demolition
26 56 00 00	26 00 00 00	Electrical Demolition
26 56 00 00	26 51 00 00	Interior and Exterior Lighting
26 56 13 00	26 00 00 00	Electrical Demolition
26 56 13 00	26 51 00 00	Interior and Exterior Lighting
26 56 23 00	26 00 00 00	Electrical Demolition
26 56 23 00	26 51 00 00	Interior and Exterior Lighting
26 56 36 00	26 00 00 00	Electrical Demolition
26 56 36 00	26 51 00 00	Interior and Exterior Lighting
26 56 43 00	26 00 00 00	Electrical Demolition
26 56 43 00	26 51 00 00	Interior and Exterior Lighting

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