



**The University of Texas
Health Science Center at Houston**

Medical School

GENERATOR REPLACEMENT

FOR
UTHSC MEDICAL SCHOOL BUILDING (MSB)

ISSUED FOR CONSTRUCTION
SEPTEMBER 30, 2016



**SHAH SMITH
& ASSOCIATES, INC.**

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09/30/2016

SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2012.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.
- C. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- D. FM 4991 - Approval Standard for Firestop Contractors; Factory Mutual Research Corporation; 2013.
- E. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- F. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
 - 1. Approved by Factory Mutual Research Corporation under FM 4991, or meeting any two of the following requirements:
 - 2. With minimum 3 years experience installing work of this type.
 - 3. Able to show at least 5 satisfactorily completed projects of comparable size and type.

1.06 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 FIRESTOPPING - GENERAL REQUIREMENTS

- A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.02 FIRESTOPPING SYSTEMS

- A. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches (100 mm) or less: Caulk or putty.
 - 1. Floors: UL Design No. F-A-1046, F Rating 2 hour.
 - 2. 2-hour fire barriers and shaft walls: UL Design No. W-L-1146, F Rating 2 hour.
 - 3. 1-hour fire barriers and shaft walls: UL Design No. W-L-1146, F Rating 1 hour.
- B. Firestopping at Combustible Pipe and Conduit Penetrations, of diameter 4 inches (100 mm) or less: Intumescent elastomeric wrap strip with aluminum facing.
 - 1. Floors: UL Design No. F-A-2110, F Rating 2 hour.
 - 2. 2-hour fire barriers and shaft walls: UL Design No. W-L-2003, F Rating 2 hour.
 - 3. 1-hour fire barriers and shaft walls: UL Design No. W-L-2003, F Rating 1 hour.
- C. Firestopping at Openings with No Penetrating Items: Pillows with caulk or putty.
 - 1. 2-hour fire barriers and shaft walls: UL Design No. W-L-0011, F Rating 2 hour.
 - 2. 2-hour fire barriers and shaft walls: UL Design No. W-L-0011, F Rating 1 hour.
- D. Firestopping at Cable Penetrations, not in Conduit or Cable Tray: Intumescent elastomeric wrap strip with aluminum facing and caulk or putty.
 - 1. 2-hour fire barriers and shaft walls: UL Design No. W-L-3030, F Rating 2 hour.
 - 2. 1-hour fire barriers and shaft walls: UL Design No. W-L-3030, F Rating 1 hour.
- E. Firestopping at Penetrations with Insulated Metallic Pipe: Intumescent elastomeric wrap strip with aluminum facing and caulk or putty.
 - 1. Floors: UL Design No. F-A-5029, F Rating 2 hour.
 - 2. 2-hour fire barriers and shaft walls: UL Design No. W-L-5001, F Rating 2 hour.
 - 3. 1-hour fire barriers and shaft walls: UL Design No. W-L-5001, F Rating 1 hour.
- F. Firestopping at Penetrations with Rectangular Steel Duct: Packing material with sealant or caulk.
 - 1. 2-hour fire barriers and shaft walls: UL Design No. W-L-5001, F Rating 2 hour.
 - 2. 1-hour fire barriers and shaft walls: UL Design No. W-L-5001, F Rating 1 hour.
- G. Firestopping Between Edge of Floor Slab and Curtain Wall (without Penetrations): Fiber firestopping with smoke seal coating; UL Design No. _____, T Rating 3/4 hour.
- H. Firestopping Between Top of Partition Wall and Floor Slab: Fiber firestopping with smoke seal coating; UL Design No. HWD-0020, Assembly Rating: 2 hour.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authority having jurisdiction.
- C. Install labeling required by code.

3.04 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 08 91 00
LOUVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Louvers, frames, and accessories.

1.02 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2013.
- B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2012.
- C. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices; 2013.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.
- C. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blankout areas required, and frames.
- D. Test Reports: Independent agency reports showing compliance with specified performance criteria.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include lubrication schedules, adjustment requirements.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.

1.05 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide twenty year manufacturer warranty against distortion, metal degradation, and failure of connections.
 - 1. Finish: Include coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wall Louvers:
 - 1. Construction Specialties, Inc; ____: www.c-sgroup.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LOUVERS

- A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified in accordance with AMCA 511.
 - 1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf (1.2 kPa) without damage or permanent deformation.
 - 2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft (3.1 g/sq m) water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
 - 3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
 - 4. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers.

- B. Stationary Louvers, Type ____: Horizontal blade, formed galvanized steel sheet construction, with intermediate mullions matching frame.
 - 1. Blades: Straight.
 - 2. Frame: 4 inches (100 mm) deep, channel profile; corner joints mitered and, with continuous recessed caulking channel each side.
 - 3. Steel Thickness, Galvanized: Frame 16 gage, 0.0598 inch (1.52 mm) minimum base metal; blades 16 gage, 0.0598 inch (1.52 mm) minimum base metal.
 - 4. Steel Finish: Superior performing organic coatings, finished after fabrication.

2.03 FINISHES

- A. Superior Performing Organic Coatings: AAMA 2605 multiple coat, thermally cured polyvinylidene fluoride system.

2.04 ACCESSORIES

- A. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.
- B. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install louver assembly in accordance with manufacturer's instructions.
- B. Install louvers level and plumb.
- C. Align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- D. Secure louver frames in openings with concealed fasteners.

3.02 CLEANING

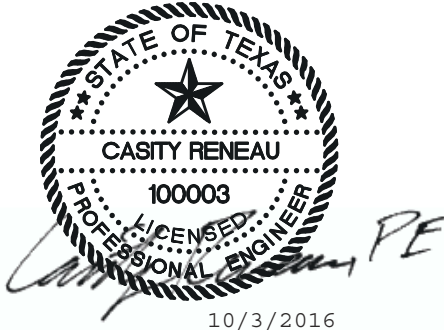
- A. Strip protective finish coverings.
- B. Clean surfaces and components.

END OF SECTION

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10/3/2016

Shah Smith & Associates, F-2113

SECTION 23 00 10

MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Except as modified in this Section, General Conditions, Special Conditions, applicable provisions of Division 01, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23.
- B. Applicable provisions of this Section apply to all Sections of Division 23 HVAC.
- C. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements, and provide coordination drawings.
- D. All work in these Sections shall be installed by craftsmen skilled in their trade.
- E. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 019000, General Commissioning, for detailed commissioning requirements.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Furnish: The term "furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. 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.

- H. Provide: The term "provide" means to furnish and install, complete and ready for the intended use.

1.3 CODE REQUIREMENTS AND PERMITS

- A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
- B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. Obtain and pay for all permits and inspections.
- D. The following building codes are applicable to this project.
 - 1. 2012 International Mechanical Code
 - 2. 2012 International Building Code
 - 3. 2009 International Energy Conservation Code
 - 4. State Energy Conservation Office (SECO) mandated state building compliance with ASHRAE 90.1-2010

1.4 REFERENCES

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, AWWA Specifications, Federal Standards or other standard specifications must comply with latest editions except where specified otherwise in individual Sections, revisions, amendments, or supplements in effect on date bids are received.
- B. Requirements in reference specifications and standards are minimums for all equipment, materials and work. In instances where capacities, size or other features of equipment, devices, or materials exceed these minimums, meet listed or shown capacities.

1.5 SUBMITTALS

- A. Equipment and Materials submittals must show sufficient data to indicate complete compliance with contract documents as follows:
 - 1. Proper sizes and capacities.
 - 2. That the item will fit in the available space in a manner that will allow proper service.
 - 3. Construction methods, materials, and finishes.
- B. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.
- C. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data for review for items of equipment and for principal materials proposed for installation. HVAC controls may be submitted separately provided the controls submittal is complete and coordinated with all other applicable trades. Include identifying symbols and equipment numbers

used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.

- D. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.
- E. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.
- F. Refer to Section 01 33 00 for additional submittal requirements

1.6 COORDINATION DRAWINGS

- A. Prior to starting work, the Contractor shall provide coordination drawings for all areas of the building.
- B. CAD. Provide 1/4 inch scale coordination drawings for all areas of the buildings for approval by Architect/Engineer.
 - 1. Drawings shall show all equipment, ductwork, cable trays, fire protection system, coil pull spaces, chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room to verify space allocation and coordination of trades.
 - 2. Provide plan and elevation views detailing installation.
 - 3. Drawings shall include 1/4 inch scale drawing of each mechanical room. Drawing shall show coil pull spaces and coordination of all ductwork, all chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room. Provide plan and elevation views detailing installation
 - 4. Contractor may not proceed with construction of MEP systems until Drawings have been reviewed by the Architect, Engineer and Owner.]
- C. Composite. The respective Sub Contractors shall prepare one complete set of composite drawings.
 - 1. The sheet metal shop drawings shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the electrical conduit, mechanical piping, plumbing piping and fire protection piping shall be overlaid and drafted onto the composite drawing. In renovation areas, contractor shall revise existing structural and architectural backgrounds as required to resolve conflicts to match field conditions exposed during demolition operations. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of any work.
 - 2. In area of congestion (where simply overlaying and drafting will create an unreadable product) the plan view scale shall be increased and/or multiple layered views shall be developed. Elevations of the individual elements shall be established and elevations shall be drawn to illustrate that the ductwork, piping, conduit, etc. will co-exist within the available space and

- that the proper access to equipment, valves, filters, etc. has been established for operation, service, removal and replacement.
3. The completed "Composite Drawings" shall be submitted to the architect for review prior to installation. Any work that proceeds without appropriate coordination and review will be subject to removal and relocation at no additional cost.
- D. Electronic.
1. Reserved for future Navisworks requirement

1.7 INTERFERENCE DRAWINGS

- A. Interference drawings are drawings that indicate conflict between the various systems and other components of the building such as beams, columns, walls, etc. They shall be drawn to scale and shall include plans, elevations, sections and other details as required to clearly define the interference and to indicate the contractor's proposed solution.
- B. They shall be submitted for approval whenever job measurements and an analysis of the drawings and specifications by the contractor indicate that the various systems cannot be installed without significant deviation from the intent of the contract. When such interference is encountered, work shall cease in the general area of the conflict until a resolution to the question has been approved.

1.8 GUARANTEE

- A. Guarantee work for one year from the date of final acceptance of the project. During that period make good any faults or imperfections that may have arisen due to defects or omissions in materials or workmanship.

1.9 SERVICE

- A. Perform service work required during the guarantee period including lubrication of bearings. Perform manufacturer's recommended monthly service and provide Owner with written report. Cleaning of air filters and pipe strainers is not included.

1.10 RESOLUTION OF CONFLICTS

- A. Where conflicts may exist between and/or within the drawings and/or specifications, the higher quality, greater quantity, more restrictive, and/or more expensive requirement shall be required and shall be the basis of Contractor pricing. The Contractor shall notify the A/E for resolution of the issue prior to executing the work in question.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacture, where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are listed in individual Sections of Division 23. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.
- B. Manufacturers' names and catalog numbers specified under Sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition.
- C. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturers' list will be acceptable on approval.
- D. Substitutions:
 - 1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/ Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
 - 2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
 - 3. The Architect/Engineer will not give approval to material salesmen or subcontractors, and only in writing to the successful Contractor after the project has been awarded.
 - 4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
 - 5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
 - 6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.
 - 7. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural or architectural, which may result from the substitution.
 - 8. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

2.3 NOISE AND VIBRATION

- A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost

to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate (without cost to the Owner) that equipment performs within designated vibration limits indicated in the specifications, or as specified by manufacturer.

- B. Seal all wall and partition penetrations (the penetration opening shall be one inch larger than penetrating member) by ducts and piping by stuffing the annular void with fiberglass insulation and then caulking over fully with a non hardening acoustical caulking applied to both sides of wall or partition.

2.4 AIR FILTERS AND PIPE STRAINERS

- A. Immediately prior to final acceptance of project, inspect, clean and service hydronic system strainers and replace disposable type air filters.
- B. Turn over to Owner additional sets of spare filters and other spare parts as specified.

2.5 ACCESS DOORS

- A. Provide access doors for all walls or ceiling locations as required for access to valves, controls, regulating devices, water arresters, fire dampers, air distribution boxes, and other concealed equipment requiring maintenance adjustment or operation. Coordinate location with General Contractor.
- B. Basis-of-Design Product: Design of access doors is based on model numbers manufactured by Milcor unless otherwise indicated. Subject to compliance with requirements, provide named product or approved equal.
 - 1. Non-Fire Rated Doors:
 - a. Furnish Milcor non-fire rated doors with 16-gage frames and 14 gage door panels.
 - b. Provide continuous concealed hinges and flush screwdriver cam lock.
 - c. Use Style M for prime painted steel, and MS for stainless steel.
 - d. Use Style DW access door for drywall or gypsum construction.
 - e. Use Style CF for suspended drywall ceilings.
 - f. Use Style K for plastered walls and ceilings.
 - g. Use Style AP for acoustical plastered ceilings with all galvanized construction.
 - 2. Fire-Rated Access Doors:
 - a. Furnish Milcor, UL listed, 1-1/2 hour, "B" label for service access in walls of stairwell, corridors and all other areas where fire-rated construction occurs.
 - b. Access doors shall have a 16 gage steel frame and 20 gage insulated sandwich type insulated panel.
 - c. Use ATR for fire-rated suspended drywall ceilings.
 - 3. Provide spring-loaded door for automatic closure and exterior key lock for security.

2.6 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all

materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cooperation with Other Trades: Cooperation with trades of adjacent, related, or affected materials or operations and of trades performing continuations of work under subsequent contract is considered a part of this work in order to effect timely and accurate placement of work and to bring together in proper and correct sequence the work of such trades.
- B. Workmanship: Work must be performed by workmen skilled in their trade.
- C. Installation of all equipment and materials must be complete. Installation shall meet requirements of specifications and manufacturer's recommendations.
- D. Electrical Wiring of Motors and Equipment. The Contractor shall note that the electrical design was based upon the mechanical equipment indicated on the mechanical construction documents and specifications. If Contractor proposes any mechanical equipment that requires changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 SPACE REQUIREMENTS

- A. Consider space limitations imposed by contiguous work, including clearances required for service, in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
- B. The following space allocation and coordination shall be followed, unless otherwise indicated on the construction drawings:
 - 1. Gravity-fed plumbing and roof drain line shall take priority over all other systems.
 - 2. Light fixtures and cable tray arrangements shall take priority in spatial layout. In areas with ceilings, other systems shall be routed above the light fixtures, and offset from above cable tray allowing for access and maintenance clearance.
 - 3. Install HVAC ductwork as close to the bottom of structural framing as possible while allowing clearance for installation of insulation wrap. Install ductwork to be accessible from the ceiling plane.
 - 4. Install HVAC chilled/hot water piping in the plane directly below HVAC ductwork unless indicated otherwise on drawings.
 - 5. Install fire sprinkler piping in the plane directly beneath the HVAC chilled/hot water piping. Do not install sprinkler piping directly below equipment requiring maintenance.
 - 6. Install domestic hot and cold water in the plane directly above the light fixtures.
 - 7. Refer to Division 26 for electrical and control wiring requirements.
 - 8. Install piping to permit removal of coils at air handling units and to permit access to all terminal unit components.

3.3 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.
- C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.4 OPENINGS

- A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.5 ACCESS DOORS

- A. Coordinate location of access doors for ease of operation and maintenance of concealed equipment.

3.6 DELIVERY, STORAGE AND HANDLING

- A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.
- B. Cover all equipment stored exposed to elements with waterproof tarps, provide adequate ventilation.
- C. At work completion, all work must be clean and in like new condition.
- D. Storage of all mechanical equipment, piping materials and ductwork shall be in strict accordance with manufacturers written installation instructions.
- E. Rotate air handler fans and pump shafts on routine basis.
- F. Provide factory installed pipe caps for all pipes to be installed on the project.
- G. Provide covers over all openings in ductwork stored or installed on the project.
- H. Energize motor heaters with temporary power as soon as the motor is received on site.
- I. Air Handling Units shall not be used as storage containers

3.7 LUBRICATION AND OIL

- A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication.

3.8 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections for Interior Painting and Exterior Painting.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Pipe Coding:
 - 1. Paint all piping white. Each line shall receive pipe marker as specified.
 - 2. Paint pipe in accordance with the following painting schedule:

PAINTING SCHEDULE
Color Code – Finish Coats

<u>Item</u>	<u>Color</u>
Treated Water	Federal Safety White
Drain and Exhaust	Navy Gray
Caustic	Federal Safety Red
Acid and Chemical	Federal Safety Purple
Chilled Water	Cascade Green
Condenser Water	Federal Safety Green
Air	Marlin Blue
Anything Hot	Federal Safety Orange

3.9 CUTTING AND PATCHING

- A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.
- B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
 - 1. Do not use impact-type equipment except where specifically acceptable to the Architect/Engineer.
 - 2. Core drill openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., to exact size.
- C. Restoration: Restore all openings to "as-new" condition under the appropriate Specification Section for the materials involved
- D. Match remaining surrounding materials and finishes.
- E. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
- F. Provide adequate support during cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall

be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

- G. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.10 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

- A. The temperature within the generator room shall be kept above 40 degrees Fahrenheit at all times.

3.11 OPERATING TESTS

- A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner's Representative.
- B. Prove operations of control systems and all safeties, freezestats and alarms.
- C. Make adjustments as required to ensure proper functioning of all systems.
- D. Special tests on individual systems are specified under individual Sections.
- E. Functional Performance Testing is part of the Commissioning Process. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Agent. Refer to Section 019113, General Commissioning, for functional performance testing and commissioning requirements.

3.12 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings in accordance with Specification 01 78 23. Detailed requirements for these items are as follows:
 - 1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
 - a. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
 - b. Special tools and equipment required for testing and maintenance.
 - c. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
 - d. Recommended spares by part number and nomenclature and spare stocking levels.
 - e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
 - f. Troubleshooting, checkout, repair and replacement procurement procedures.

- g. Operating instructions including start up and shutdown procedures.
 - h. Safety considerations including load limits, speed, temperature and pressure.
2. Provide O&M manuals for all HVAC equipment.

3.13 PROJECT RECORD DOCUMENTS

- A. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.
- B. Mark the drawings with a colored pencil.
- C. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed.
- D. At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these.
- E. Delivery of as-built prints and reproducibles is a condition of final acceptance.

3.14 TRAINING

- A. Upon completion of work, and at time designated by the Owner's Representative, provide services of a competent representative of the manufacturer/Contractor to instruct the Owner's Representative and up to 8 members of the Owner's staff in the operation and maintenance of the entire system. Record training sessions on DVDs for instructing future technicians.

B. Provide training for the following pieces of equipment:

Items:	HRs of Training Pre-Substantial Completion	HRs of Training at 6 months from Substantial Completion	HRs of Training at 11 months from Substantial Completion	Video Taping Required
Electric Unit Heaters	2			X

- C. All training sessions shall be scheduled in coordination with the Owner's Representative 14 days in advance, attendance taken, and sign-in sheet and training materials included in the O&M manuals.

END OF SECTION

SECTION 23 31 13

DUCTWORK

PART 1 - GENERAL

1.1 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
- B. Section Includes:
 - 1. Rectangular ducts and fittings.
 - 2. Round ducts and fittings.
 - 3. Double-Wall Ductwork
 - 4. Sheet metal materials.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.
- C. Related Sections:
 - 1. Division 09 Section, Painting, for interior painting of metal ductwork exposed to view through grilles, registers, and other openings.
 - 2. Section 23 33 00, Ductwork Accessories, for dampers, spin-in fittings, flexible duct connections.

1.2 DEFINITIONS

- A. Low Pressure: Up to 2 inches w.g. positive or negative static pressure and velocity equal to 1500 fpm. Constructed and tested for +2 inches W.G.
- B. Medium Pressure: Over 2 inches w.g. through 6 inches w.g. positive or negative static pressure and velocity greater than 1500 fpm. All medium pressure ductwork shall be constructed and tested for +6 inches w.g.
- C. High Pressure: Over than 6 inches w.g. positive static pressure and velocity greater than 2500 fpm.
- D. Duct Size. The supply, return and exhaust duct sizes shown on drawings are clear inside sheet metal dimensions.

1.3 GUARANTEE

- A. Guarantee all ductwork for 1 year from the date of final acceptance. The guarantee will cover workmanship, noise, chatter, whistling or vibration. Ductwork shall be free from pulsation under all conditions of operation.

1.4 CONTRACTOR COORDINATION

- A. Erect all ducts in the general locations shown on the drawing(s), but conform to all structural and finish conditions of the building. Before fabricating any ductwork, Contractor to check the physical conditions at the job site and make all necessary

changes in cross sections, offsets and similar items, whether they are specifically indicated on drawing(s) or not. Do not obstruct the induced air plenum opening at VAV boxes and service access spaces for VAV boxes and other equipment.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

1.5 STANDARDS AND CODES

- A. Except as otherwise indicated, sheet metal ductwork material, fabrication and installation shall comply with second edition of SMACNA HVAC Construction Standards Metal and Flexible, except where indicated otherwise. All air distribution devices (such as dampers) included in this Section shall comply with the second edition of SMACNA HVAC Construction Standards Metal and Flexible.
- B. In addition, construct ductwork and all air distribution devices to the following:
 - 1. IMC International Mechanical Code
 - 2. SMACNA Round Industrial Duct Construction Standards
 - 3. SMACNA The Managers' Guide for Welding

1.6 SUBMITTALS

- A. Product Data
 - 1. Submit product data for each product. Refer to Section 23 00 10.
- B. Delegated-Design Submittal. Include the following for each system furnished on the project.
 - 1. System name and type
 - 2. Duct system design pressure.
 - 3. Sheet metal thicknesses and materials.
 - 4. Reinforcement details and spacing.
 - 5. Seam and joint construction and sealing.
 - 6. Fittings, construction and details.
 - 7. Hangers and supports, including materials, fabrication, methods for duct and building attachment.
- C. Ductwork shop drawings. Provide CAD-generated shop drawings of mechanical rooms and building ductwork drawn at a minimum scale of ¼ inch per foot. Include the following as a minimum:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory and shop fabricated duct and fittings.
 - 3. Duct layout indicating sizes, configuration and pressure classes.
 - 4. Elevations of top and bottom of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Reinforcement and spacing.
 - 7. Penetrations through fire-rated and other partitions.
 - 8. Equipment installation based on equipment being used on Project.
 - 9. Duct accessories, including access doors and panels, fire dampers and smoke dampers.

- D. Samples.
 - 1. Provide a sample of all type of ductwork to Engineer and Owner for approval.
- E. Welding certificates. For duct welders including procedures and standards of acceptance

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Sheet Metal Products. McCorvey Sheet Metal Works, Gowco, United McGill, Flexmaster
- B. Double-Wall Flue – Schebler, Selkirk, Metal-Fab, Van Packer

2.2 APPLICATION

- A. Ductwork shall be constructed in accordance with the following as a minimum. Refer to drawings for any deviations from this table.

SYSTEM	MATERIAL	MINIMUM PRESSURE CLASSIFICATION ⁽¹⁾
Supply Systems:		
General Exhaust/Relief Systems:		
Radiator Exhaust	Galvanized Steel	Not more than 18 gauge.
Miscellaneous Exhaust Systems:		
Generator exhaust	316L Stainless steel, schedule 10S, Type S or E.	Refer to Specs

- B. Notes to Table:
 - 1. Positive pressure unless noted otherwise in Table.
 - 2. From air handling unit (AHU) to terminal boxes.
 - 3. From pretreatment AHU to AHU.
 - 4. Runout from air device to return/exhaust air trunk duct
 - 5. Negative pressure SMACNA table.

2.3 DUCT MATERIAL AND CONSTRUCTION

- A. General. Noncombustible or conforming to requirements for Class I air duct materials or UL 181. 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. Galvanized Steel Ducts. Constructed of G-60 coated galvanized steel meeting requirements of ASTM A 653 or ASTM A 527. Stencil coils of sheet steel throughout on 10 foot centers with gage and manufacturer's name. All materials associated with the duct system shall be galvanized steel including stiffeners, fasteners, etc.

- C. Stainless Steel Ducts. Type 304 or 316L as indicated in application schedule. For round ductwork, butt-welded (solid welded) longitudinal seam only. Spiral lockseam and Spiral lockseam with standing rib is not acceptable.
- D. Fasteners. Rivets, bolts or sheet metal screws.
- E. Sealant.
 - 1. 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 Foster 32-19, Childers CP-146, Hard Cast Iron Grip 601, Ductmate Pro Seal or Design Polymerics DP 1010.
 - 2. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count.
- F. Hangers and Supports.
 - 1. Support ductwork with continuously threaded hanger rods of galvanized steel or 20 gauge straps as indicated in these specifications.

2.4 RECTANGULAR DUCTS AND FITTINGS GENERAL REQUIREMENTS

- A. General Fabrication Requirements: Comply with SMACNA based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage for low pressure ductwork, 24 gage for medium pressure ductwork.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Snaplock longitudinal seams (L2) are not acceptable.
- D. Fittings:
 - 1. Select types and fabricate according to SMACNA Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
 - 2. Construct bends and elbows per SMACNA Figure 2-2, "Rectangular Elbows", Type RE1 with radius of not less than 1-1/2 times width of duct on centerline. Where not possible or where indicated on construction documents, construct Type RE2 rectangular elbows with welded-in-place double wall airfoil turning vanes (whether specifically shown on drawings or not), or short radius type RE1 radius elbows.
 - 3. Construct tees per SMACNA Figure 2-5, "Divided Flow Branches", Type 2, Type 3, Type 4A or 4.
 - 4. Construct branch connections per SMACNA Figure 2-6, "Branch Connection". Use 45 degree entry, 45 degree lead in, conical or bellmouth connections only.
 - 5. Unless indicated on construction document details, transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence. Divergence upstream of equipment shall not exceed 30 degrees. Convergence downstream of equipment shall not exceed 45 degrees.

6. Bullhead tees are not permitted.

2.5 ROUND AND OVAL DUCTS AND FITTINGS GENERAL REQUIREMENTS

- A. General Fabrication Requirements: Comply with SMACNA Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Use flanged joints for ducts larger than 48 inches in diameter.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Utilize spiral seam or butt weld seams only. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
- D. Fittings:
 1. Fittings shall have a wall thickness not less than that specified for longitudinal-seam straight duct or 26 gage, whichever is more stringent.
 2. Tees and Laterals: Select types and fabricate according to SMACNA Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Utilize 90 degree tee with oval to round tap, 45 degree lateral tap, or conical fitting only. Wye fittings may be utilized where specifically indicated on drawings and details.
 3. Elbows: Construct elbows with radius of not less than 1-1/2 times width of duct on centerline. Provide minimum 5 gore elbows on all 90 deg elbows, 3 gore elbows on 45 degree elbows. Continuously welded stamped long radius elbows may be utilized on ductwork up to and including 12-inches in diameter.
 4. Bullhead tees are not permitted.

2.6 LOW PRESSURE DUCTWORK

- A. Currently reserved if we need to make a distinction between low pressure and medium pressure construction standards from the general requirements above.

2.7 MEDIUM PRESSURE DUCTWORK

- A. Currently reserved if we need to make a distinction between low pressure and medium pressure construction standards from the general requirements above.

2.8 FLUE VENT

- A. Provide for all gas fired equipment. Provide all accessories such as flue caps, support plates, ventilated roof thimble, storm collar, etc. by the same manufacturer.
- B. Type IPS Double Wall Flue. Provide UL listed pressure rated, double pipe with Type 304 stainless steel inner liner, 2 inches of fiber insulation, and Type 304 stainless steel outer jacket, similar to Metalbestos Model IPS. The vent system shall be UL tested and listed to 50"W.G and 1000°F continuous operating conditions.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Construction Standards. Use construction methods which follow the requirements outlined SMACNA publications, as well as SMACNA Balancing and Adjusting publications, unless indicated otherwise in these specifications or accompanying drawings.
- B. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.
- C. Plenum Construction. Construct plenum chambers of not less than No. 20 U.S. gage metal reinforced with galvanized structural angles.
- D. Cross Breaking or Beading. Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.
- E. Wall and Floor Penetrations.
 - 1. Where ducts pass through walls in exposed areas, install suitable escutcheons made of galvanized sheet metal angles as closers.
 - 2. At all locations where ductwork passes through floors, provide watertight sleeves projecting 3 inches above finished floor and flush with bottom of floor slab. Fabricate sleeves of 1/8 inch thick steel, galvanized after fabrication. Anchor into adjacent floor slab as required.
 - 3. Sleeves are required inside as well as outside chases.
- F. Interior Painting. Interior painting of metal ductwork exposed to view through grilles, registers, and other openings is specified in the Section on painting. Do not install grilles, registers, or similar items until painting is complete.
- G. Ductwork Openings. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Ductwork Location. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities, including access to electrical and control panels.
- I. Provide transitions at equipment and air device connections as per SMACNA standards. Where equipment requires an oval inlet and a round flex duct is routed to the equipment, provide insulated round to oval transition.

3.2 SEAM AND JOINT SEALING

- A. All duct systems (except welded exhaust ductwork and double wall flue) shall be sealed. Duct shall be thoroughly cleaned prior to application of sealant. All transverse joints, longitudinal seams and duct wall penetrations shall be sealed. All ductwork shall be sealed as per seal Class A of SMACNA Standards irrespective of the duct pressure classifications

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports." Unless indicated otherwise in specifications.
- B. Hanger Spacing. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing. Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection. Do not use wire to support ductwork.
- C. Horizontal Ducts Up to 40 Inches. Support horizontal ducts up to and including 40 inches in their greater dimension by means of No. 20 U.S. gage band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beam clamps or other approved means. Use clamps to fasten hangers to reinforcing on sealed ducts.
- D. Horizontal Ducts Larger Than 40 Inches. Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron trapeze hangers. Place supports on at least 8'-0" centers according to the following:

Angle Length	Angle	Rod Diameter
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"

The trapeze is to be placed on the exterior of non-compressible insulation between hanger and ductwork.

- E. Vertical Ducts. Support ducts to ensure rigid installation. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Fig. 4-7, Fig 4-8, Fig 4-9 "Riser Supports – From Floor". Support vertical ducts where they pass through the floor lines with 1-1/2 inches x 1-1/2 inches x 1/4 inch angles for ducts up to 60 inches. Above 60 inches, the angles must be increased in strength and sized on an individual basis considering space requirements. Support vertical duct drops more than 6 feet in length with angle iron frames attached to ducts.
- F. Refer to drawings for additional hanger details and requirements. Note that not all hangers are shown on the drawings are in the BIM model. The Contractor shall coordinate all hangers with the structure and other trades.

3.4 LOW PRESSURE DUCTWORK

- A. Currently reserved if we need to make a distinction between low pressure construction standards from the general requirements above.

3.5 MEDIUM PRESSURE DUCTWORK

- A. Currently reserved if we need to make a distinction between medium pressure construction standards from the general requirements above.

3.6 FLUE VENTS

- A. General. Install ductwork in accordance with manufacturer's recommendations and International Building Code and Mechanical Code requirements. Maintain minimum clearances from combustible materials. Provide ventilated roof thimble, storm collar, flashing and cap. Maintain necessary clearances from vertical walls, outside air intakes and roofs per Code Requirements. Provide guy wires for any flue vent termination greater than five foot above the roof.
- B. Type B Flues. All exhaust system parts exposed to the atmosphere shall be protected by a minimum of one base coat and one finished coat of paint, such as Series 4200 or 4300 heat resistance paint as manufactured by Rust-Oleum Corp.
- C. Type AL 29-4C Flues. Contractor shall install manufacturer provided drain at bottom of stack. Drain shall be routed to nearest floor drain. Seal all ductwork as recommended by manufacturer.
- D. Generator Exhaust.
 - 1. Provide 316L stainless steel schedule 10S pipe, Type E or S, with butt weld fittings.

3.7 FLASHING

- A. Where ducts pass through roofs or exterior walls, provide suitable flashing to prevent rain or air currents from entering the building. Provide flashing not less than No. 26 gage stainless steel or 16 ounce copper. Flashing for generator exhaust may be silicone master flash or equal.

3.8 TESTS

- A. Allowable Leakage. Test ductwork for leaks in accordance with SMACNA before concealing or insulating as indicated below. Arrange for the Owner's Representative to witness the test.
 - 1. Low pressure ductwork. Test low pressure ductwork at +3 inches W.G. Maximum allowable leakage (Lmax) per 100 ft² of ductwork shall be equal to $C_L \times P^{0.65}$, where $C_L = 6$ for rectangular ducts and round flexible ducts, $C_L = 3$ for round/flat oval ducts, and $P = 3"$ for low pressure ducts.
 - 2. Medium pressure ductwork. Test medium pressure ductwork at +6 inches W.G. Maximum allowable leakage (Lmax) per 100 ft² of ductwork shall be equal to $C_L \times P^{0.65}$, where $C_L = 6$ for rectangular ducts and round flexible ducts, $C_L = 3$ for round/flat oval ducts, and $P = 6"$ for medium pressure ducts.
 - 3. Lab exhaust ductwork. Test laboratory exhaust ductwork at +6 inches w.g. Maximum allowable leakage is 1/2% of the total system air flow rate. Where partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
 - 4. Test the following ductwork:
 - a. Other
 - 1) Do not test Double Wall Flue Piping or Dryer Exhaust Ductwork.

5. Generator exhaust shall be pressure tested at 1 psig with air for 8 hours with no pressure loss.

B. Equipment. Provide equipment necessary for performing tests, including rotary blower, orifice section and U-tube gage board complete with cocks and rubber tubing.

3.9 CLEANING

A. Protect all ductwork and equipment from dirt during storage, installation and prior to grille, diffuser installation with protective covering at each end. Ductwork exposed to dirt and dust due to inadequate protection will have to be removed, cleaned and reinstalled.

B. Do not operate any air handling units or fan coil units during construction without filters.

C. Provide temporary filters on return air ductwork during construction to protect ductwork from dust.

D. Provide temporary filters on exhaust grilles during construction to protect ductwork from dust.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Duct access doors.
 - 2. Duct accessory hardware.
 - 3. Flexible Connection

1.2 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specification 23 31 13, Ductwork

1.3 SUBMITTALS

- A. Product Data: Submit product data for each product. Refer to Section 23 00 10.
- B. Access Doors. Include type of material, installation guidelines, leakage rates and maximum pressure data.
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Control damper installations.
 - c. Wiring Diagrams: For power, signal, and control wiring.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.

1.5 QUALITY ASSURANCE

- A. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
 - 2. AMCA 500-D, "Laboratory Method of Testing Dampers for Rating"
 - 3. NFPA 101 - Life Safety Code.
 - 4. SMACNA - HVAC Duct Construction Standards Metal and Flexible – Second Edition
 - 5. UL 555 – Standard for Fire Dampers.
 - 6. UL 555C – Standard for Ceiling Radiation Dampers.

7. UL 555S – Standard for Smoke Dampers

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flexible Connections. Ductmate, Ventfabrics Ventglass.
- B. Duct Access Doors. Ductmate Flexmaster, Greenheck, Ruskin, United McGill.

2.2 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316L, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

2.3 DUCT ACCESS DOORS

- A. Square Frame Access Doors
 - 1. Low Pressure Ductwork
 - a. Construct outer frame of minimum 22 gage roll formed galvanized steel with installation tabs. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 2 manually operated cam locks on access doors 16-inches and under, 4 cam locks for doors greater than 16-inches. Provide foam gasket seal between door and frame and between frame and duct.
 - b. Performance. 24"x24" access door shall be suitable for up to 2"W.G. and have a maximum leakage of 0.15 CFM/sq.ft. at 1"W.G. pressure.
 - 2. Medium Pressure Ductwork
 - a. Construct outer frame of minimum 22 gage roll formed galvanized steel with installation tabs. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 4 manually operated cam locks on access doors 16-inches and under, 8 cam locks for doors greater than 16-inches. Provide foam gasket seal between door and frame and between frame and duct.
 - b. Performance. 24"x24" access door shall be suitable for up to 10"W.G. and have a maximum leakage of 0.15 CFM/sq.ft. at 1"W.G. pressure.

- B. For stainless steel ductwork, provide stainless steel finish to match ductwork material.
- C. Where duct size permits, access door size shall be 18-inches in diameter or 18" x 16" for oval and rectangular doors. For duct sizes under 20-inches, provide access door 2-inches smaller than duct size. For ducts 12-inches wide, provide minimum 10" x 12".

2.4 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Drill temporary test holes for balancing in ducts as required. Cap with neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Provide neat patch on external duct insulation and label as "Test Plug".
- C. Provide permanent test holes in ductwork upstream and downstream of all coils, fans, and locations as indicated on drawings. Test holes shall be factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FLEXIBLE CONNECTIONS

- A. Provide air-tight flexible connections where ductwork connects to generator radiator exhaust with fabric as specified below:

Application	Fabric	Coating	Gauge
Generator Radiator Exhaust Duct	Fiberglass	Silicone	24

- B. The fabric shall be UL listed, fire retardant, waterproof and mildew resistant, crimped into metal edging strip.
- C. The fabric coating shall be suitable for use in temperatures greater than 200 degrees Fahrenheit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install test holes at fan inlets and outlets and elsewhere as indicated.

3.2 ACCESS DOORS

- A. Install duct access doors on sides or bottom of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. As indicated on drawings, details or specifications.

- B. Label access doors to indicate the purpose of access door.

3.3 FLEXIBLE CONNECTIONS

- A. Install at connections between ductwork and motor driven equipment as shown. Provide a minimum of 1 inch slack in the connections, and a minimum of 2-1/2 inches distance between the edges of the ducts and equipment. Also provide a minimum of 1 inch slack for each inch of static pressure on the fan system. Securely fasten flexible connections to equipment and to adjacent ductwork by means of sealant with sheet metal screws. Where flex ductwork is connected to oval collars in diffusers and plenums, provide a metal transition fitting from oval to round.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Inspect locations of access doors and verify that purpose of access door can be performed.

END OF SECTION

SECTION 23 82 39

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This section specifies furnishing and installing UL Labeled electric unit and wall mounted heaters with operating and safety controls.

1.2 RELATED WORK

- A. Controls.
- B. Electrical Division 26.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Plans, elevations, sections, and details.
 - 2. Location and size of each field connection.
 - 3. Equipment schedules to include rated capacities, furnished specialties, and accessories.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacturer of products specified in this Section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products in compliance with the specifications and manufactured by the following manufacturers are acceptable: Modine, Trane, Reznor or approved equivalent.

2.2 ELECTRIC UNIT HEATERS

- A. Provide horizontal delivery unit heaters fabricated of heavy gauge steel finished with a durable powder coated paint finish. The units shall be complete with adjustable discharge louvers and threaded openings on the top of the unit for unit suspension by brackets or threaded rods.

- B. Heating elements shall consist of nickel-chromium resistance wire surrounded with magnesium oxide, sheathed in steel spiral-finned tubes. Provide minimum kilowatt capacity as scheduled.
- C. Motor provided for each unit shall be totally enclosed, continuous duty with automatic resetting thermal overload protection. Propeller fan shall be directly connected to the motor and shall be statically and dynamically balanced. Motor shall be mounted to the unit with rubber vibration absorbing grommets.
- D. Provide fan guard and mounting hardware for ceiling installation.
- E. Controls and Electrical:
 - 1. Unit shall be arranged for single point power connections of the voltage as scheduled for the heating element.
 - 2. All units shall include all operating and safety controls as required by UL and NEC.
 - 3. All units shall have built-in contactors and control circuit transformers.
 - 4. Provide a grounding lug and wiring diagram in each control compartment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units at locations as indicated on the drawings, in accordance with the manufacture's installation instructions and NEC. Refer to division 26 for wiring and electrical installation requirements.
- B. Thermostats shall maintain space temperature at heating set points as determined by Owner. Controls sub contractor shall provide and install controls as required including but not limited to thermostats, temperature sensors, controllers, wiring, contactors etc.

END OF SECTION

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SECTION 26 00 00.01

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 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 specification.

1.2 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 05 00 - Electrical General Provisions.
- 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

2.1 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

3.1 EXAMINATION

- A. All demolitions or modifications to existing systems shall be coordinated through Owner'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.

3.2 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. Owner reserve 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 Owner at least (2) 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 Owner at least (2) 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 Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 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.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets 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 Owner's Representative.
- K. Where equipment is indicated to be demolished and returned to Owner, the Contractor shall include the delivery of this equipment to the Owner's site storage area. Remove

with care all equipment to be relocated. Repair or replace of newly damaged equipment is the responsibility of the Contractor.

3.4 CLEANING AND REPAIR

- A. The Contractor shall follow Owner's clean work policy and shall include the removal of trash and demolished material from the building or work area at the end of the 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.
- 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.

3.5 DISPOSITION OF MATERIAL AND EQUIPMENT

- A. Review with the Owner materials that have been removed and are no longer required, to determine any which the Owner may desire to keep. Deliver those materials that the Owner desires to the Owner's specified location.
- B. For those materials not required by the Owner, dispose of them in accordance with applicable regulations.

END OF SECTION

SECTION 26 05 00

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide labor, materials and equipment required for complete and functioning electrical systems as required by the contract documents.
- B. New Work. The work includes, but is not limited to, the following principal systems and equipment:
 - 1. Medium Voltage distribution (>1000V).
 - 2. 480/277 volt distribution.
 - 3. 208/120 volt distribution.
 - 4. Switchgear.
 - 5. Panelboards-Distribution, Branch Circuit and Electronic Grade.
 - 6. Transformers-General purpose, K-factor, and Harmonic Cancelling.
 - 7. Luminaires, poles, lamps and ballasts.
 - 8. Fire alarm system.
 - 9. Grounding and bonding system.
 - 10. Motor controllers.
 - 11. Variable frequency drives for AC electric motors. Furnished by Division 23, installed by Division 26.
 - 12. Electric motors. Furnished and installed by Divisions 21, 22 and 23. Electrical connections by Division 26.
- C. Empty Raceway. Refer to Division 27 telephone/data and Division 28 security specifications for cabling requirements. Provide empty raceway for the following systems:
 - 1. Communications: Computer system cables and outlets. Refer to telecommunications Drawings for additional work.
 - 2. Communications: Telephone system cables and outlets. Refer to telecommunications Drawings from additional work.
 - 3. Security system cables and devices. Refer to Security Drawings for additional work.
- D. Demolition. Refer to demolition Drawings and Section 26 00 00.01 for scope of work.

1.2 APPLICABLE PROVISIONS

- A. Provisions Specified Elsewhere. Unless modified in this Section, General and Supplementary General Conditions, applicable provisions of Division 01 - General and other provisions of contract documents apply to work of Division 26 - Electrical.
- B. Application. Provisions of this Section apply to every section of Division 26 - Electrical, except where specifically modified.
- C. Work covered by this Section shall be accomplished in accordance with applicable provisions of the Contract Documents and addenda or directives which may be issued herewith, or otherwise.

1.3 RELATED WORK

- A. Existing Conditions - Division 02.

- B. Sealing and Firestopping – Division 07.
- C. Openings - Division 08.
- D. Finishes - Division 09.
- E. Equipment - Division 11.
- F. Furnishings – Division 12.
- G. Conveying Equipment – Division 14.
- H. Fire Protection – Division 21.
- I. Plumbing – Division 22.
- J. Heating, Ventilation and Air Conditioning – Division 23.

1.4 REFERENCE CODES AND STANDARDS

- A. Standards of the following organizations may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.
- B. Association of Edison Illuminating Companies (AEIC).
- C. American National Standards Institute (ANSI).
- D. Institute of Electrical and Electronics Engineers (IEEE).
- E. Insulated Cable Engineers Association (ICEA).
- F. National Electrical Code (NEC).
- G. National Electrical Manufacturers Association (NEMA).
- H. National Electrical Safety Code (NESC).
- I. National Fire Protection Association (NFPA).
- J. Underwriters' Laboratories (UL).
- K. ASHRAE/IESNA 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.5 REGULATIONS AND PERMITS

- A. Regulations. Work, materials and equipment must comply with the latest rules and regulations of the following:
 - 1. National Electrical Code (NEC).
 - 2. National Electrical Safety Code (NESC).
 - 3. Occupational Safety and Health Act (OSHA).
 - 4. Americans with Disabilities Act (ADA).
 - 5. Texas Department of Licensing and Regulation (TDLR).
 - 6. Texas Occupational Code.

7. Texas Electrical Safety and Licensing Act – Title 8, Occupations Code Chapter 1305.
 8. State and federal codes, ordinances and regulations.
- B. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's representative in writing, including a proposed resolution, and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.
- C. Permits: Obtain certificates of inspection and other permits required as a part of the work. Submit written evidence to the Owner's Representative and Architect/Engineer that the required permits and inspections have been secured.

1.6 DRAWINGS AND CONTRACT DOCUMENTS

- A. Intent: The intent of the construction Drawings or contract documents, hereinafter referred to as the "Drawings", is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system. The Drawings, specifications, and related contract documents are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Electrical Drawings, are generally diagrammatic and show approximate location and extent of the work. Review pertinent Drawings and adjust the work to conditions shown. Install the work complete, including minor details necessary to perform the function indicated.
- B. The Contractor shall carefully investigate structural and finish conditions, and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceways, subject to prior review by the Owner's Representative. Work shall be organized and laid out in finished portions of the building so that it will be concealed in furred chases, suspended ceilings, and similar elements of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. Discrepancies: In case of doubt as to work intended, or if amplification or clarification is needed, or where discrepancies occur between Drawings, specifications, and actual field conditions, immediately notify the Architect/Engineer and the Owner's Representative in writing, requesting an interpretation, and include a proposed solution.
- D. Dimensions: Dimensional information related to new structures shall be taken from the appropriate Drawings. Dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.
- E. Outlet and Equipment Locations: Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical, telecommunications, audio-visual (AV), security, plumbing, and laboratory Drawings. Review with the Owner's Representative proposed changes in outlet and equipment location. Relocation of outlets before installation of up to 5 feet from the position indicated may be directed without additional cost to the Owner. Remove and replace outlets placed in unsuitable locations, when so requested by the Owner's Representative, and at no additional cost to Owner.

1.7 SUBMITTALS

- A. Submit the following in addition to and in accordance with the requirements of the Uniform General Conditions and in Division 01, Submittals.
 - 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 catalog cuts shall not be acceptable unless applicable portions are clearly indicated and non-applicable portions clearly deleted or crossed out.
 - 3. Schematic, connection and/or interconnection diagrams.
 - 4. Provide submittals as required by individual specification section.

- B. Provide the following with each submittal:
 - 1. Catalog cutsheets with manufacturer's name clearly indicated. Applicable portions shall be clearly indicated by arrows, circles, or similar markings and non-applicable portions shall be clearly deleted or crossed out.
 - 2. Line-by-line specification review by equipment manufacturer and contractor with exceptions explicitly defined.
 - 3. Itemize and organize equipment and material submittals by specification Section number; include manufacturer and identifying model or catalog numbers.
 - a. Submittal packages for product data, shop drawings, and other required submittals shall be numbered sequentially according to the applicable specification Section number. For example, the first submittal package for Energy-Efficient Dry-Type Transformers shall be identified as Submittal number 262213-01. The second submittal package for Energy-Efficient Dry-Type Transformers would be identified as Submittal number 262213-02. Re-submittal packages shall be identified by an "R" in the sequential numerical suffix.
 - b. Where directed by the Owner or the Architect to combine submittals into a common package, the submittal data may be organized in one or more 3-ring binders or similar container. Product data, shop drawings, and other submittal data shall be organized in separate tabs according to paragraph 1.07B.3a, above. That is, submittal data in individual tabs of a common submittal package shall be numbered sequentially, according to the applicable specification Section number.
 - 4. Replace rejected items and resubmit with acceptable items in accordance with the requirements of Division 01 for Submittals, and with the Uniform General Conditions.

- C. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.
 - 1. Itemize equipment and material by specification section number; include manufacturer and identifying model or catalog numbers.
 - 2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
 - 3. If a satisfactory replacement is not submitted within a two-week period, Owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at not additional cost to Owner.

- D. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads shall be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.

- E. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict

and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also submit the following for review:

1. Electrical and Telecommunications Rooms. Submit 1/4-inch scale coordination drawings of electrical and telecommunications rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.
 2. Mechanical and Pump Rooms. Submit 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of electrical equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.
 3. Corridors. Submit 1/4-inch scale coordination drawings, including sections, of corridors indicating equipment and material.
 4. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.
 5. Review: The completed "Composite Drawings" shall be submitted to the Architect/Engineer for review prior to installation. Work that proceeds without appropriate coordination and review will be subject to removal and relocation at no additional cost to the Owner.
- F. Installation: Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by Owner's Representative. Use only equipment and materials accepted by the Architect/Engineer and by Owner's Representative. Equipment and materials installed prior to acceptance by the Owner/ Engineer and Owner's Representative shall be removed at no additional cost to Owner and replaced at the Contractor's expense.
- G. Startup and Test Procedures:
1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
 2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.
 3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.

4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.
- H. As-Built and Record Drawings:
1. Maintain a master set of as-built drawings that show changes and other deviations from the Drawings. The markups must be made as the changes are done.
 2. At the conclusion of the project, these as-built drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner's Representative, and shall be complete.
 3. Prior to final acceptance, deliver to the Owner's Representative the AutoCAD electronic files, the complete set of record drawings showing the as-built condition of the project, and the actual field set of as-built drawings. Also deliver one set of as-built drawings on CD-Rom or similar electronic media acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).
 4. Quantity: In accordance with the requirements of Division 01 and the General Conditions. Where not specified elsewhere, provide 3 hard copies plus one reproducible set.
- I. Operating and Maintenance Manuals: As specified in Part 3 of this Section and in Division 01, as applicable.
- J. Overcurrent Protective Device Coordination Study: Provide preliminary and final study as specified in Section 26 05 73. Make adjustments to materials and submittals under other Sections of Division 26 as required and as recommended by the Overcurrent Protective Device Coordination studies.

1.8 SUBSTITUTIONS

- A. Refer to requirements of Division 01 for substitution of Material and Equipment.
- B. Product manufacturers are listed to establish a level of quality for the products. Substitutions may be allowed if the product is equal to or better than what is listed in the design guidelines, as determined by the Architect/Engineer and owner's Representative upon submittal of comparison products.
- C. Samples: When requested by the Owner's Representative or the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. When requested, provide samples of both the specified item and the proposed item for comparison purposes.
- D. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. Time periods for Architect/Engineer processing and review of submittal data, shop drawings, samples, studies, and reports shall be in accordance with the applicable submittal and substitution requirements of Division 01 and the General Conditions. The Contractor shall allow sufficient time for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles for processing of submittal data and shop drawings, including time for resubmittal cycles on unacceptable and rejected materials, equipment, components, and systems covered by the data submitted. Construction delays and lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in requests for scheduled construction time extensions and additional costs to the Owner.
- E. Acceptance: Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings

indicating compliance with the Drawings, specifications, and other applicable Contract Documents, and that adequate and acceptable clearances will exist for entry, servicing, and maintenance. Acceptance of materials and equipment under this provision shall not be construed as authorizing deviations from the Specifications, unless the attention of the Owner's Representative and the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless pertinent information is properly identified.

- F. Replacement; Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment originally specified at no additional cost to the Owner.

1.9 CONTRACTOR QUALIFICATIONS

- A. An acceptable Contractor for the work under this division must have personnel with experience, training and skill to provide a practical working system.
 - 1. The Contractor may be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project. The systems must have served satisfactorily for not less than 3 years. The superintendent must have had experience in installing not less than three such systems.
 - 2. The Contractor must have personnel with the proper licenses to perform electrical work under this Contract. In accordance with the Texas Electrical Safety and Licensing Act – Title 8, Occupation Code, Chapter 1305, Subchapter D, section 1305.151: "LICENSE REQUIRED. Except as provided by Section 1305.003, a person may not perform electrical work unless the person holds an appropriate license issued or recognized under this chapter."
- B. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of the Project Safety Manual (PSM).
 - 1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.
 - 2. The Contractor shall secure electrical rooms, to limit access, prior to energizing high voltage (1000V or higher) equipment, and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is ongoing near energized equipment. The Contractor shall cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.
 - 3. The Contractor shall strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

- A. Condition. Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.
- B. NEC and UL.

1. Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products and issued labels, products used must be listed and labeled by UL.
 2. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Where no specifications or specific model numbers are given, provide materials of a standard industrial quality.
- C. Space Limitations: Equipment selected must conform to the building features and must be coordinated with them. Electrical installation shall comply with the requirements of Article 110.26 and Article 110.34 of the National Electric Code (NEC) for working space, access, and dedicated equipment space. Do not provide equipment that will not suit arrangement and space limitations. Scaled drawings (1/4" = 1'-0") of equipment rooms shall be submitted for review by the Architect/Engineer and the Owner's Representative prior to installing equipment. See paragraph 1.07E above.
- D. Factory Finish. Equipment shall be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.
- E. Physical Size of Equipment: Equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless the Contractor demonstrates by product data, shop drawings, and coordination drawings that ample space exists for proper installation, operation, and maintenance.
- F. Enclosure: Provide NEMA 1 enclosure for indoor installation and NEMA 3R for outdoor enclosure, unless noted or specified otherwise. The enclosure shall be suitable for the environment per NEC, NEMA and ANSI standards.
- G. Conductors in Conduit: Conductors shall be installed in conduit. Exceptions are listed in individual Sections of the Division 26 specifications.
- H. Non-Ferrous: Use non-ferrous materials in rooms with equipment employing magnetic equipment with elevated gauss fields, such as Nuclear Magnetic Resonance (NMR) and Magnetic Resonance Imaging (MRI) equipment. Use non-ferrous materials where gauss fields extend into adjacent spaces, and other locations as indicated on Drawings.

2.2 MANUFACTURER

- A. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer, except as specifically noted in individual Sections of the specifications.

2.3 SUBSTITUTIONS

- A. Refer to Division 01 section on Material and Equipment, and to paragraph 1.08 of this Section.

2.4 NAMEPLATES AND DEVICE MARKING

- A. Refer to Section 26 05 53, Identification For Electrical Systems.

2.5 AUTOMATED EQUIPMENT AND CONTROLS

- A. Equipment and control systems where applicable, shall match, integrate, communicate and cooperate with new and existing systems, such as building automation, energy management, direct digital controls (DDC), fire detection and alarm, circuit breakers, transformers, etc.

PART 3 - EXECUTION

3.1 GENERAL

- A. **Manufacturer's Recommendations:** The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, wiring, and connection of equipment and material. Promptly notify the Architect/Engineer and the Owner's Representative in writing of conflicts between the requirements of the Drawings and specifications and the manufacturer's directions, in accordance with paragraphs 1.05B and 1.06C of this Section. Obtain instructions from the Owner's Representative before proceeding with the work. Should the Contractor perform work that does not comply with the manufacturer's directions or such instructions from the Owner's Representative, he shall bear costs arising in connection with the deficiencies.
- B. **Site Observation:** Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Drawings, specifications, and other applicable Contract Documents. Site observation by the Architect/Engineer shall not be construed as construction supervision, or indication of approval of the manner or location in which the work is being performed, or as being a safe practice or place. Site observation by the Architect/Engineer shall not be construed as inspection by the Authority Having Jurisdiction (AHJ) or other applicable code enforcement authority.
- C. **Installation:** Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by the Owner's Representative. Use only equipment and materials accepted by the Architect/Engineer and the Owner's Representative. Equipment and materials installed prior to acceptance by the Architect/Engineer and Owner's Representative shall be removed at no additional cost to Owner and replaced at the Contractor's expense.
- D. **Supervision:**
 - 1. The Contractor of the work under this Division shall keep a competent superintendent or foreman on the job throughout the period of construction. Refer to Division 01 requirements and the Uniform General Conditions for additional information concerning supervision.
 - 2. It shall be the responsibility of such superintendent to study the Drawings, specifications, and other applicable Contract Documents, and familiarize himself with the work. He shall coordinate his work with other trades before material is fabricated or installed, and ensure that his work will not cause interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the Contractor. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the Architect/Engineer and the Owner's Representative for resolution in accordance with paragraphs 1.05B and 1.06C of this Section.

3.2 PROTECTION OF EQUIPMENT AND MATERIALS

- A. **General:**
 - 1. The Contractor shall follow the manufacturer's directions completely in the delivery, storage and handling of equipment and materials.
 - 2. Equipment and materials shall be tightly covered and protected against dirt, water, chemical, physical or weather damage and theft. At the completion of the work,

- fixtures, equipment and materials shall be cleaned and polished thoroughly and shall be returned to "as new" condition.
3. Electrical cable, wire, and conductors shall be stored to prevent moisture and mechanical damage.
- B. Moisture. During construction, protect switchboard, 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 on receiving the products and maintain continually.
 - C. Clean. Keep products clean by elevating above ground or floor and by using suitable coverings.
 - D. 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.
 - E. Finish. Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore finishes that become stained or damaged.
 - F. Weather. Protect equipment and materials from weather and sunlight by use of suitable coverings and storage indoors, or in suitable weather-protected containers. Materials and equipment marked by their manufacturer as suitable for storage outdoors may be stored according to manufacturer's markings. Maintain factory-installed coverings and wrappings until material is to be installed.

3.3 PREPARATION

- A. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also prepare the following:
 1. Electrical Rooms. Prepare 1/4-inch scale coordination drawings of electrical rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.
 2. Mechanical and Pump Rooms. Prepare 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of electrical equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been

proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

3. Corridors. Prepare 1/4-inch scale coordination drawings, including sections, of corridors indicating equipment and material.
4. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.
5. Review: The completed "Composite Drawings" shall be prepared prior to installation. Work that proceeds without appropriate coordination will be subject to removal and relocation at no additional cost to the Owner.

B. Test Procedures:

1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.
3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.
4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.

3.4 SAFETY

A. Implement the following safety procedures in addition to, and in accordance with, the requirements of Division 01 and the Uniform General Conditions:

1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel of hazards particular to this project and update the information as the project progresses.
2. Prior to energizing panelboards within the scope of work, secure affected electrical rooms to limit access to line voltage. Line voltage shall be defined as above 50 volts, for the purpose of controlling access. During and after energization of panelboards, control access to electrical rooms for the duration of the project. Post and maintain warning and caution signage in areas where work is on-going near energized equipment. Cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.
3. Strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

3.5 INSPECTION

A. Examination. Examine the areas and conditions under which equipment and systems are to be installed, and notify the Owner's Representative 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.

B. Coordination. Carefully investigate structural and finish conditions and coordinate the work 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, suspended ceilings, and similar elements in finished portions of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

3.6 INSTALLATION

- A. Cooperation with Other Trades. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades. Provide other trades, as required, templates, patterns, setting plans and shop details for the proper installation of the work and for purposes of coordinating adjacent work. Electrical power connections for mechanical and plumbing equipment are in this Division unless noted otherwise. Verify electrical characteristics of equipment with other Divisions before roughing in the electrical connections.
- B. Workmanship. Work shall be performed by workmen skilled in their trade. The installation shall be complete and installed in a neat and workmanlike manner in accordance with NEC 110.12 and FPM accompanying, and as described in ANSI/NECA 1-2000 "Standard Practices for Good Workmanship in Electrical Contracting", and other ANSI approved installation standards.
- C. Concrete Equipment Pads.
1. Refer to structural Drawings and specifications for design criteria.
 2. Where not otherwise indicated, install 2 inch thick reinforced concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required such as at the metal platform. For equipment mounted outdoors, provide concrete foundations a minimum of 6 inches above grade. Provide reinforcing steel as recommended by the structural engineer and as detailed on the Drawings. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond equipment. Trowel pads smooth and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.
 3. Anchor Bolts. Furnish and install galvanized anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.
- D. Setting of Equipment. Provide permanent and temporary shoring, anchoring, and bracing required to make parts stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.
1. Equipment must be leveled and set plumb.
 2. Sheet metal enclosures mounted against a wall shall be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers, or by 3 inches of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment.
 3. In sufficient time to be coordinated with work under other divisions, provide shop drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
 4. Provide adequate support for freestanding panels, switchboards, enclosures, and other equipment. This shall include bolting to the floor, concrete equipment pad, or solid structural steel to prevent tipping. Install free-standing electrical equipment on concrete equipment pads in accordance with paragraph 3.05C, this Section, except where equipment is noted and designed for mounting directly on the concrete floor

- slab. Under no condition shall equipment be fastened to non-rigid building steel such as removable platform steel gratings, handrails, etc.
5. Provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. Do not mount or suspend equipment from supports provided for equipment and systems by other Divisions, except where specifically noted or indicated on Drawings.
 6. Refer to Section 26 05 29, Metal Framing and supports, for additional requirements.
- E. Sealing of Equipment. Seal openings into equipment to prevent entrance of animals, birds and insects, as well as to prevent ingress of moisture, dust, dirt, and similar contaminants.
- F. Motors.
1. Motors are specified in Divisions 21, 22 and 23.
 2. Electrical work includes the electrical connection of motors, except those which are wired as a part of equipment.
 3. Refer to Division 23 and other applicable Divisions for wiring and connection of motors and equipment furnished by those Divisions.
 4. The Contractor shall note that the electrical Drawings are based on the equipment scheduled and indicated on the Drawings. Should mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.
 5. Provide interconnecting wiring for the installation of the power required. Provide disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. Combination starters, individual starters, and other motor starting apparatus, not specifically scheduled or specified as provided by the equipment manufacturer under the scope of other Divisions shall be provided under the scope of Division 26.
 6. Other Divisions will provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review. Diagrams will be based on accepted equipment and be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. They will be followed in detail. For additional clarification, refer to Division 23, Controls.
- G. Concealed Work. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:
1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
 2. Where exposure is necessary to the proper function.
 3. Where size of materials and equipment preclude concealment. Obtain the written consent of the Owner's Representative and the Architect/Engineer to leave materials exposed in finished spaces of the building.
- H. Application. Unless otherwise indicated, power will be utilized as follows:
1. 480 volts, three phase: motors 3/4 horsepower and larger.
 2. 120 volts, single phase: motors 1/2 horsepower and smaller.
 3. 277 volts, single phase: fan powered boxes.
 4. 120 volts, single phase: incandescent lighting.
 5. 277 volts, single phase: fluorescent and high-intensity-discharge lighting.
 6. 120 volts, single phase: convenience outlets, dedicated equipment, lab-track terminal boxes without fans.
 7. 208 volts, single and three phase: specialty outlets.
 8. 480 volts, three phase: special power and equipment; verify for each unit of equipment.
- I. Transformers. Use transformers to change the service to the required utilization voltages.

- J. Connections to Equipment - Other than Division 26. For equipment furnished under other Divisions, and for equipment furnished by the Owner, provide final electrical connections to such items of equipment. Obtain detailed shop drawings of equipment from the applicable Division or supplier indicating the exact number and location of rough-in points. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions. Making adjustments to field conditions is considered a part of the work required.
1. Roughing-in: When roughing-in, provide electrical branch circuits to various items of equipment. Terminate at proper points as indicated on detailed equipment shop drawings, or as directed. Use Drawings accompanying these specifications only for general routing of circuiting. Do not use Drawings accompanying these specifications for rough-in locations.
 2. Final Connections: Millwork, casework, and similar equipment will include service fittings such as switches, duplex receptacles, data/communications outlets, and luminaires on the casework or equipment. Provide branch circuit connection to match electrical connection requirements of service fittings.
- K. Accessories. Offsets, fittings, expansion joints, anchors and accessories that are required for a complete system shall be provided, even if not specifically indicated on the Drawings or mentioned in the specifications. Offsets, transitions and changes in direction of conduit, cable trays, raceways and busways shall be made to maintain proper headroom. Provide pullboxes, fittings, etc., required as a result of these transitions and changes in direction.
- L. Observation prior to cover-up or seal-in of walls and ceilings. Perform the following in accordance with the applicable requirements of Division 01 and the General Conditions:
1. Prior to the installation of ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the Owner's Representative so that arrangement can be made for observation or inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide advance notice in accordance with the applicable requirements of Division 01 and the General Conditions. Where not specified, required, or directed elsewhere, provide not less than 10 working days' advance notice.
 2. Above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. Electrical work at and above the ceiling, including items supported by the ceiling grid, shall be complete and installed in accordance with contract requirements, including power to luminaires, fans, and other powered items. The purpose of this inspection is to verify the completeness and quality of the installation of the electrical systems and other above ceiling special systems such as cable tray systems. The ceiling supports shall be in place so that access panel and luminaire locations are identifiable, and so that clearances and access provisions may be evaluated.
 3. No ceiling materials may be installed until the resulting deficiency list from this inspection is completed and approved by the Owner's Representative.
- M. Finish. Coordinate with Division 9 to paint exposed conduit to match adjacent walls, unless otherwise directed.

3.7 EXISTING FACILITIES

- A. Responsibility. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and maintenance of electrical services for new and existing facilities. The Contractor shall erect temporary

barricades, with necessary safety devices, as required to protect personnel from injury, removing such temporary protection upon completion of the work.

- B. Services. The Contractor shall provide temporary or new services to existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.
- C. Access. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, luminaries, air conditioning ductwork and equipment, etc., to provide this access, and shall reinstall same upon completion of work in the areas affected.
- D. Existing Devices. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, remove and reinstall in locations approved by the Architect/Engineer devices required for the operation of the various systems installed in the existing construction. This is to include, but is not limited to, temperature controls, system devices, electrical switches, relays, luminaires, fixtures, piping, conduit, etc.
- E. Outages. Outages of services as required by the new installation will be permitted, but only at a time approved by the Owner. The Contractor shall coordinate with the Owner's Representative to arrange for service outages. The Contractor shall allow the Owner sufficient time to schedule for required outages, in accordance with the applicable requirements of Division 01 and the General Conditions. Where not specified, required or directed elsewhere, allow a minimum of 21 working days for the Owner to schedule for required outages. The time allowed for outages will not be during normal working hours or during hours of research and instruction, unless otherwise approved by the Owner's Representative. Costs of outages, including overtime charges, shall be included in the contract amount.
- F. Adjacent Facilities. Coordinate work among the various trades to minimize disruption to existing processes, procedures, and equipment in spaces adjacent to areas of demolition and renovation work. Coordinate with Owner's Representative to schedule work producing noise or structure-born vibrations, including but not limited to cutting, drilling, coring, and use of impact tools.

3.8 EQUIPMENT AND DEVICE MARKING

- A. Designations. Identify equipment, devices, feeders, branch circuits and similar items with the same designations as indicated on the Drawings.
- B. Nameplates. Externally mark electrical equipment with nameplates identifying each and the equipment served. Supply blank nameplates for spare units and spaces.
- C. Refer to Section 26 05 53 for additional requirements.

3.9 SLEEVES, PENETRATION, CUTTING AND PATCHING

- A. General. Cut and patch walls, floors, etc., resulting from work in existing construction. Provide for the timely placing of sleeves for raceway and exposed cabling passing through walls, partitions, beams, floors and roof while same are under construction. If openings, sleeves, and recesses are not properly installed and cutting and patching become necessary, it shall be done at no expense to the Owner. Secure permission from the Owner's Representative before cutting or patching a constructed or existing wall. Where roofs or walls are fire rated, penetrations shall be completely sealed using UL-listed materials and

procedures sufficient to preserve the fire rating. Comply with special requirements of local authorities.

- B. Structure. Do not cut or core through structural beams, joists, load-bearing walls, grade beams, or similar load-bearing structure. Where limited space is available above the ceilings below concrete beams or other deep projections, notify the Owner's Representative in writing, including a proposed solution, and request a resolution. Approval shall be obtained from the Owner's Representative and the Architect/Engineer for each penetration.
- C. Penetrations.
1. This contract requires core drilling of floor or wall penetrations as indicated on Drawings. Core drilling shall be in accordance with structural specifications. Floor penetrations shall include a sleeve that extends above the floor 2 inches, except where plugs and caps are specified or indicated flush with floor or foundation pad. Electrical penetrations shall be coordinated with structure during design, and shall be made in compliance with structural requirements specified in the structural Drawings and specifications. Field modifications are required to be reviewed and approved by structural engineer prior to installation.
 2. Penetrations shall be sealed in accordance with the requirements of Division 7, Firestopping. Coordinate with Division 7 to provide firestopping systems and materials that are compatible with the penetrations for systems and equipment furnished and installed under Division 26.
 3. Provide sleeves for conduit penetrations of smoke, fire, and sound rated partitions. Install sleeve with a minimum of 1 inch diameter where penetrating the exterior drywall.
 4. Provide proper sizing of sleeves or core-drilled holes to accommodate their through-penetrating items. In general, provide conduit sleeves two standard sizes larger than their through-penetrating items. Provide larger sleeves as required to allow passage of couplings for through-penetrating items.
- D. Sealing and Firestopping.
1. Voids between sleeves or core-drilled holes and pipe passing through fire-rated assemblies shall be firestopped to meet the requirements of ASTM E 814, in accordance with Division 7 requirements for Firestopping.
 2. Where the routing of cable tray passes through fire-rated walls, floors or other fire-rated boundaries, coordinate with Division 7 to provide removable firestopping system.
 3. Furnish and install UL Systems Classified, intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250° F, for the sealing of holes or voids created to extend electrical systems through fire rated floors and walls, in order to prevent the spread of smoke, fire, toxic gas or water.
 4. Fire barrier products shall be used to create through-penetration firestop systems as required. Firestop systems shall be listed in the Underwriter's Laboratories Building Materials Discovery, Through Penetration Firestop Systems (XHEZ).
 5. Install firestop materials and systems according to their UL Systems Classifications, manufacturer instructions, manufacturer recommendations, and the requirements of applicable Division 7 specifications.
- E. Conduit Sleeves. Conduit sleeve shall be two standard sizes larger than the size of conduit it serves, except where "Link Seal" casing seals are used in sleeves through walls below grade. Sleeves in floor shall extend a minimum of two inches above the finished floor. Conduit passing through concrete masonry walls above grade shall have 18-gauge galvanized steel sleeves. Sleeves set in concrete floor construction shall be at least 16-gauge galvanized steel except at conduit supports. Sleeves set in concrete floor construction supporting

conduit risers shall be standard weight galvanized steel. Sleeves supporting conduit risers 3 inches and larger shall have three 6 inch long reinforcing rods welded at 120 degree spacing to the sleeve, and shall be installed embedded in the concrete or grouted to existing concrete. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve. Seal around penetrations through sleeving as indicated under firestopping as specified herein, and in compliance with the requirements of Division 7 specifications.

- F. Penetrations Below Grade. Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4-inch thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be two inches wider in radius than the sleeve it encircles. The entire assembly shall be hot-dipped galvanized after fabrication. Seal off annular opening between conduit and sleeve with "Link Seal" casing seal as manufactured by Thunderline Corporation of Wayne, Michigan. Size conduit sleeve to accommodate the casing seal. Use Series 300 casing seals for pipe 3/4-inch through 4-inch and Series 400 casing seals for pipe sized 5-inch and larger.
- G. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and core drills, and at such locations acceptable to the Owner's Representative. Impact type equipment shall not be used except where specifically accepted by the Owner's Representative. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.
- H. Restoration. Restore openings to "as new" condition under the appropriate specification Section for the materials involved, and match remaining surrounding materials and/or finishes.
- I. Masonry. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Provide adequate supports during the cutting operation to prevent damage to the masonry caused by the cutting operation. Structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner's Representative.
- J. Structure. No cutting, boring, or excavating which will weaken the structure shall be undertaken. Coordinate with structure for placement of conduit, sleeves, and the like through beams, joists, slabs, mats, and other structural components and systems prior to forming of those structural components and systems.
- K. Watertight. Where sleeves pass through roof or floors requiring waterproof membrane, lead flashing with a density of at least three pounds per square foot shall be built into the membrane a minimum of six inches to provide a watertight installation. Provide other watertight installation materials as detailed on the Drawings and as specified under Division 7 – Roofing.
- L. Escutcheons. Provide heavy chrome-plated or nickel-plated plates on conduit passing through walls and ceilings in finished areas. Escutcheons shall be B&C No. 10, or accepted substitution, chrome-plated steel plates with concealed hinges.
- M. Roof Penetrations and Flashings. Furnish and install pipe, conduit and duct sleeves, and flashing compatible with the roofing installation for roof penetrations. Coordinate with Division 7.

3.10 CLEANING, ADJUSTING AND START-UP

- A. Cleaning. Clean electrical equipment, components, and devices prior to installation of final finish or covers, prior to startup and testing, prior to final observation by Architect/Engineer

and Owner's Representative, and as required under individual Sections of the Division 26 specifications.

- B. Adjusting. Adjust equipment, devices, and systems as specified under individual Sections of these Specifications and in accordance with manufacturer's instructions for proper functioning during modes of operation, including emergency and shutdown conditions.
- C. Factory Authorized Representative. Where specified for an individual item of electrical equipment, provide a factory authorized representative for adjustment, start-up, and testing of equipment, and instruction of Owner's operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

3.11 TESTING

- A. Test Conditions. Use field startup and testing procedures submitted in accordance with paragraph 1.07G of this Section and accepted by the Owner's Representative and the Architect/Engineer. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.
- B. Test Conditions. Use field startup and testing procedures prepared in accordance with paragraph 3.03B of this Section. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.
- C. Test Dates. Schedule final acceptance tests sufficiently in advance of the contract completion date to permit adjustment and alterations within the number of days allotted for completion of the contract. Inform the Owner's Representative in advance of test dates in accordance with the applicable requirements of Division 01 and the General Conditions. Where not specified, required, or directed otherwise, allow a minimum of at least 10 working days advance notice.
- D. Retests. Conduct retests as directed by the Owner's Representative of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Delays resulting from retests do not relieve the Contractor of his responsibility under this contract.
- E. Commissioning. Coordinate with commissioning agent, as applicable, for field testing and commissioning of electrical components and systems.
- F. Test Reports. Submit copies of test reports to the Architect/Engineer in accordance with Division 01 requirements.

3.12 OPERATING AND MAINTENANCE MANUALS

- A. General. The Contractor shall provide, in loose-leaf binders, complete operating and maintenance data of each manufactured item of equipment used in the electrical work at least four weeks before Architect/Engineer's final review and observation of the project. Descriptive data and printed installation, operating and maintenance instructions for each item of equipment will be included. A complete double index will be provided as follows.
- B. Format and content. The Operating and Maintenance Manual will be submitted in quantities and format as specified under Division 01 for Submittals. Provide quadruplicate where quantity is not specified. Operating and Maintenance Manual shall include:
1. Descriptive data of each system and piece of equipment, including ratings, capacity, performance data, operating curves and characteristics, and wiring diagrams.
 2. Full detailed spare parts list, including source of supply for each piece of equipment.
 3. Printed instructions describing installation, operation, service, maintenance, and repair of each piece of equipment.
 4. Typewritten test reports of tests made of materials, equipment and systems under this Division. Test reports will include the dates of the tests, name of person conducting and witnessing the tests, and record of conditions relative to the tests.
 5. Copies of "Reviewed" shop drawings and submittals.
 6. Print copies of the record Drawings. Refer to paragraph 1.071 of this Section.

END OF SECTION

SECTION 26 05 19
INSULATED CONDUCTORS

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section specifies the furnishing and installation of insulated conductors.

1.2 REFERENCE STANDARDS

- A. AEIC No. 6 - Specifications for Ethylene-Propylene-Rubber-Insulated Power Cables 5,000 to 35,000 Volts.
- B. ANSI/IEEE 386 - Separable Insulated Connectors for Power Distribution Systems Above 600 Volts.
- C. ANSI/UL 83 - Thermoplastic-Insulated Wires and Cables.
- D. ANSI/UL 1072 - Medium-Voltage Power Cables.
- E. IEEE No. 48 - Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.
- F. ICEA S-61-402 (NEMA WC 5) - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- G. ICEA S-68-516 (NEMA WC 8) - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- H. ANSI/UL 2196 "Tests for Fire Resistive Cables"
- I. CSA C22.2 #124
- J. UL Fire Resistance Directory

1.3 SUBMITTALS

- A. Provide product data on the following:
1. 600-volt conductor, splicing and terminating materials.
 2. 5 kV insulated conductor, splicing and terminating materials.
- B. Provide cable high voltage factory test reports.

PART 2 – PRODUCTS

2.1 IDENTIFICATION

- A. Provide new insulated conductors marked according to NEC Article 310.

2.2 600-VOLT INSULATED CONDUCTORS

- A. Size. As shown on the drawings.
- B. Construction.
 - 1. Conductor. Soft-drawn, annealed copper. Solid for #12 and #10 and Stranded for all other sizes.
 - 2. Insulation. Unless otherwise noted on the drawings, use THHN/THWN-2 for general wiring. Use XHHW-XHHW-2 for conductors installed below grade.
- C. Use. For general wiring use No. 12 minimum. For field-installed control wiring use No. 14 or larger stranded conductors.
- D. Listing. Single Conductor. UL 83.

2.3 5,000-VOLT INSULATED CONDUCTORS (133% INSULATION)

- A. Size. As shown on the drawings.
- B. Single Conductor Construction.
 - 1. Single uncoated annealed copper conductor with Class B stranding.
 - 2. Extruded semi-conducting thermosetting conductor screen firmly bonded to the overlaying insulation.
 - 3. Ethylene-propylene-rubber (EPR) insulation 115 mils thick.
 - 4. Extruded semi-conducting thermosetting insulation screen.
 - 5. Copper shielding tape 5 mils thick helically applied with a minimum 12.5 percent overlap or 6 corrugated drain wires embedded in jacket.
 - 6. Polyvinyl chloride jacket 80 mils thick.
- C. High Voltage Factory Test.
 - 1. Corona level test with a maximum partial discharge of 5 picocoulombs.
 - 2. AC test: 13 kV for 5 minutes.
 - 3. DC test: 35 kV for 15 minutes.
 - 4. Insulation resistance test: IR constant to be 50,000 megohms per 1000 feet minimum.
 - 5. Use test procedures given in ICEA S-68-516 and AEIC No. 6.
 - 6. Certified test reports with test data and corona level plots are to be submitted for review prior to shipment.
 - 7. Engineer may witness test.
- D. Type. Single Conductor. MV-105.
- E. Listing. UL 1072.
- F. Acceptable Manufacturers. Okonite, Southwire, Prysmian, Kerite.

2.4 HIGH VOLTAGE TERMINATIONS

- A. Terminations.
 - 1. Terminations - Medium voltage terminations shall be equal to 3M 5630K series, Class 1, 5-35 kV, cold-shrink rubber termination kits.

- B. Compatibility. Terminating materials must be compatible with the cable supplied. Submit proof of the acceptability by the cable manufacturer of any splicing or terminating materials.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Protection. Unless otherwise indicated, mechanically protect conductors for systems by installing in raceways. Do not install the conductors until raceway system is complete and properly cleaned. Use Polywater J cable lubricant when pulling conductors. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors, or less than twelve times the outer diameter of the completed 15 kV cable. Do not exceed manufacturer's recommended values for maximum pulling tension.
- B. Splices and Terminations. Use pressure-type lugs or connectors for terminations or splices of all stranded conductors. Use ring-tongue type terminators on all control wiring. Below grade terminations shall be waterproof.
- C. Appearance. Neatly and securely bundle or cable all conductors in an enclosure using nylon straps with a locking hub or head on one end and a taper on the other.

3.2 600-VOLT INSULATED CONDUCTORS

- A. Size. Install conductor sizes as indicated.
- B. Home Runs. Provide branch circuit homeruns as indicated on plans. Homerun designations are indicated on Sheet E-001. Provide the number of homeruns as indicated on plans. A maximum of 6 phase conductors may be installed in one conduit. Include a separate neutral conductor with each phase conductor for all 120V circuits. Common neutrals are not permitted. For 277V lighting circuits one neutral conductor may be used for three phase conductors. Use home run circuit numbers as indicated for panelboard connections. For isolated ground circuits provide an additional ground conductor as indicated on the panel schedules. Provide No. 10 AWG conductor for the entire circuit length for single-phase, 20 ampere circuits for which the distance from panelboard to the last outlet is more than 100 feet for 120 volt circuits and 200 feet for 277 volt circuits.
- C. Color Code. Use factory-colored insulated conductors for No. 10 and smaller conductors and color code larger insulated conductors with an approved field-applied tape. Use different colors for control wiring. Follow the color scheme below.

<u>Line</u>	<u>208/120</u>	<u>480/277</u>
A or L1	Black	Brown
B or L2	Red	Purple
C or L3	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Switch Leg	Pink	Pink

Where more than one conductor of the same phase or more than one neutral conductor occur at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. All wiring associated with isolated ground receptacles (line, neutral, ground) shall have a yellow tracer on each conductor.

- D. Field Testing. Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Insulation resistance of conductors which are to operate at 600 volts or less shall be tested by using a Biddle Megger of not less than 1000 volts d-c. Insulation resistance of conductors rated at 600 volts shall be free of shorts and grounds and have a minimum resistance phase-to-phase and phase-to-ground of at least 10 megohms. Conductors that do not exceed insulation resistance values listed above shall be removed at Contractor's expense and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall forward copies of the test readings to the Owner in accordance with Section 26 05 00. These test reports shall identify each conductor tested, date and time of test and weather conditions. Each test shall be signed by the party making the test.

3.3 15 KV INSULATED CONDUCTORS

- A. Bonding. At each termination, bond tape shield to grounding conductor.
- B. Terminations. Provide terminations as specifically indicated. Have terminations installed by an experienced cable terminator in strict accordance with the termination manufacturer's instructions and the cable manufacturer's recommendations. Submit cable terminator's qualifications for Owner's approval.
- C. Fireproofing. Fireproof each individual high voltage insulated conductor for entire length where exposed. Use Scotch 77 tape with Scotch 69 glass cloth overlay wrapped in the opposite direction. Provide a minimum 25 percent overlap of each tape layer.
- D. Installation. Wrap cables horizontally around manhole a minimum of one time before exiting. Cable racks for cable support are existing. Use plastic cable ties to secure cables to racks.
- E. Identification. Identify each circuit with a laminated plastic tag securely fastened to the conductors with tie wrap.
- F. Field Testing:
1. High potential proof tests shall be made on all high voltage cables before final inspection and acceptance of work. Thirty days before the installation of cables is complete and ready for testing, the Contractor shall notify the Owner for approval of the testing company. The Contractor shall cooperate with and give all necessary assistance to this agency while the tests are being conducted. In the event of a test failure, Contractor shall repair any defects in installation and re-test at no additional cost to Owner.
 2. A non-destructive dc testing service, such as "Kenotron," Westinghouse "High Pot Tester," or approved substitution, capable of generating approximately 100,000 Vdc under normal leakage conditions of acceptable cable shall be used for the tests.
 3. All cables shall be tested in place with terminations made up but not connected to switchgear or any other load device or dead-end seal. Cables with dead-end seals shall be temporarily opened and resealed.
 4. In case of failure during the test, the Contractor shall locate the faulty component. The Owner shall be notified before repairs are made.

5. Should the test reports indicate that the condition of the cable is unsatisfactory, in the opinion of the Owner, the Contractor shall make all repairs and/or replacements as necessary. Additional tests shall be made at the Contractor's expense, on all repaired sections using the same testing agency. Cable installations will not be accepted until satisfactory certified proof test reports are obtained.
 6. Adequate means shall be taken to ensure safety during the tests and all safety instructions of the test operator shall be carried out.
 7. Prior to each high potential test, each high voltage cable conductor shall be separately "megged" with a 2,500-volt mega-ohms meter, or equal, from conductor to sheath or ground. Low megger readings of less than 25 mega-ohms shall be cause for rejection of the cables.
- G. Each cable shall be tested for a minimum of 10 minutes or until the current reading levels off and remains steady for at least 3 minutes. The potential shall be raised at a slow uniform rate with current readings taken every 15 seconds until full test voltage is reached; thereafter, current readings shall be recorded separately. The removal of the voltage shall be done in a manner to prevent damaging the cable.
- H. The test voltage shall be in accordance with ICEA recommended values except where the cable terminates in a switch or switchgear with a lower recommended test value, in which case the lower value shall be used. Cables with one or more switching points in a cable run shall be sectionalized with the switches and tested in sections in order to test the cable at the highest possible voltage which the ICEA recommends.

3.4 TYPE MI – MINERAL INSULATED CABLE

- A. Size – Install conductor sizes as indicated.
- B. Home runs: Install cable per manufacturer's instructions
- C. Color Code/label: Label each individual cable every 5' with the following: 600V 2HR fire rated cable.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 REFERENCES

- A. NFPA 70 – National Electrical Code.
- B. NECA 1-2000 – Standard Practices for Good Workmanship in Electrical Contracting.
- C. NFPA 99 – Standard for Health Care Facilities.
- D. Texas Department of Health Services (TDHS) – Hospital Licensing Rules.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Ground Electrode Conductors: Stranded, tinned, annealed copper cable.
- B. Equipment Grounding Conductors: As specified by Section 26 05 19, green insulation, sized in accordance with NFPA 70Code, Table 250.122.
- C. Grounding Clips: Steel City Type G, or equal.
- D. Ground Rods: Copper-encased steel, 3/4" diameter, minimum length 10 feet.
- E. Provide bare conductors for bonding jumpers.
- F. Ground Bus. Where a field-provided ground bus is required, use round-edge copper bar with 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus for not less than 25 percent of the cross-sectional area of the related feeder. A minimum size of 1/4 inch {6 mm} by 2 inches {51 mm} is required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install ground system as indicated, in accordance with the applicable requirements of the NFPA 70 and NECA 1-2000.

- B. Install #6 AWG grounding electrode conductors or larger in conduit, bonded at each end.
- C. Install grounding conductors continuous, without splice.
- D. Provide a separate, insulated equipment grounding conductor in all feeder and branch circuit conduits. Terminate each end on a grounding lug, bus, or bushing.
- E. Install Exothermic Welded ground connectors where they are concealed or inaccessible.
- F. Install internal ground wire on liquid tight flexible metal conduit.
- G. Electrical Service: Bond main switchboard ground bus to grounding electrode system.
- H. Bond all equipment cabinets, junction boxes, outlet boxes, motors, controllers, raceways, conduit, fittings, switchgear and other metallic equipment and enclosures with an equipment grounding conductor. Unless some separate grounding provision is specified or indicated, equipment and enclosures will be considered to be grounded by the continuous grounded metallic conduit or raceway system; however, provide bonding jumpers and grounding conductor shall be provided wherever necessary to insure the electrical continuity.
- I. Motors: Ground each motor by means of a separate grounding conductor securely and permanently attached to the motor housing.
- J. Dry Type Transformers:
 - 1. Transformers with Secondary Neutrals: Ground each transformer by means of a separate grounding conductor in the primary feeder conduit. Terminate the feeder conduit with a grounding bushing. Bond the grounding conductor to the secondary neutral, the transformer housing and feeder conduit grounding bushing.
- K. Conduit Grounding Bushings: Install grounding bushings on all Conduits terminating in equipment that has a ground bus. Ground each conduit by means of a grounding conductor securely and permanently attached to the grounding bushing and to the ground bus in the equipment.

3.2 GROUND RESISTANCE MEASUREMENTS

- A. Method: The Fall Of Potential method accurate within plus or minus two (2) per cent.
- B. Instrument: Biddle Digital Resistance Tester Catalog Number 250200.
- C. Maximum Acceptable Resistance: Two (2) OHMS.

- D. Documentation:
1. Method and equipment used for measurement.
 2. Calibration date of equipment used.
 3. Plot plan outlining measurement points.
 4. Name of person(s) performing measurement.
 5. Date of test.

END OF SECTION

SECTION 26 05 29

METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies the furnishing and installation of metal framing, including channels, fittings, clamps, hardware, electrical accessories and brackets.

1.2 SUBMITTALS

- A. None required.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Make channels, fittings, clamps, electrical accessories and brackets of sheet steel or of malleable cast iron. Fabricate threaded fasteners of carbon steel.

2.2 COATINGS

- A. Hot-dip galvanize all steel components utilized indoors. Provide stainless steel framing for outdoor applications.

2.3 SIZES

- A. Provide channels fabricated from not less than 12-gage sheet steel, 1-5/8 inches wide and not less than 1-5/8 inches deep.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Hot-dip galvanized steel shall be used in all areas except use stainless steel components when exposed to the weather, in the crawl space and when located in a corrosive atmosphere.

3.2 SUPPORTS

- A. Provide metal framing to support large or heavy wall-mounted equipment, wall-mounted raceways and ceiling-hung raceways. Use stainless steel channel to mount the exhaust fan disconnect switches on the roof. Supports shall be mounted independent of the fan enclosure. Secure support to roof.

3.3 ANCHOR BOLTS

- A. Use 1/2 inch diameter by 3 inches long expansion bolts to attach framing to concrete. Space bolts a maximum of 24 inches on center, with not less than two bolts per piece of framing.

3.4 TOUCH-UP

- A. Touch up all scratches or cuts on steel components with an approved zinc chromate or a 90 percent based zinc paint.

END OF SECTION

SECTION 26 05 33

RACEWAYS, CONDUIT, AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 REFERENCES

- A. ANSI C80.1 – Rigid Steel Conduit, Zinc-Coated.
- B. ANSI C80.3 – Electrical Metallic Tubing, Zinc Coated.
- C. ANSI/NEMA FB 1 – Fittings and Supports for Conduit and Cable Assemblies.
- D. ANSI/NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
- E. ANSI/UL 1 – Flexible Metal Conduit.
- F. ANSI/UL 5 – Surface Metal Raceways and Fittings.
- G. ANSI/UL 360 – Liquid-tight Flexible Steel Conduit.
- H. ANSI/UL 467 – Electrical Grounding and Bonding Equipment.
- I. ANSI/UL 797 – Electrical Metallic Tubing.
- J. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
- K. Underwriter's Laboratories Standard UL-5A.
- L. ANSI/UL 651 – Schedule 40 and 80 Rigid PVC Conduit.
- M. EIA/TIA Standard 568A.
- N. ANSI/UL 651 – Electrical Metal Tubing
- O. ANSI/UL 870 – Wireways Auxiliary Gutters and Fittings
- P. UL 6 – Rigid Metal Conduit

1.3 SECTION INCLUDES

- A. Conduit.
- B. Conduit fittings.

- C. Conduit accessories.
- D. Wireway.
- E. Boxes.

1.4 RELATED SECTIONS

- A. Division 02 - Excavation, Backfilling, and Trenching.
- B. Division 02 - Site Grounding.
- C. Division 07 - Fire Stopping.
- D. Division 07 - Roofing Penetrations.
- E. Section 26 00 00 – Basic Electrical Requirements.
- F. Section 26 05 19 – Cable, Wire and Connectors.
- G. Section 26 05 26 – Grounding.
- H. Refer to Division 01. Submit manufacturer's product data for conduit, boxes, wireways, raceways, in-ground pull boxes and manholes.

1.5 SUBMITTALS

- A. Provide submittals in accordance with Basic Electrical Requirements and Section 01330, 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.

1.6 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

2.1 CONDUIT

- A. General: Install all wiring in conduit in accordance with latest edition of National Electrical Code and these Division 26 Specifications.
- B. Application Requirements:
 - 1. Minimum Size: 3/4 inch unless otherwise specified. Flexible conduit connections to lighting fixtures may be 3/8 inch not to exceed 72 inches in length.
 - 2. General: Use rigid steel conduit for all applications except as noted below.

- C. Wet and Damp Locations: Use rigid steel conduit or rigid aluminum conduit.
- D. Dry Locations:
 - 1. Concealed: Use electrical metallic tubing (EMT) for 4" and smaller.
 - 2. Exposed in Electrical and Telephone Rooms: Use electrical metallic tubing (EMT) for 4" and smaller.
 - 3. Exposed in Other Areas Above 8': Use electrical metallic tubing (EMT) for 4" and smaller.
 - 4. AC and MC cable is not allowed.
- E. Pump Motor Connections: Use liquid-tight flexible metal conduit.
- F. Motors and Dry Type Transformer Connections: Use liquid-tight flexible metal conduit not exceeding 72" in length.
- G. Rigid Steel Conduit: Hot dip galvanized, including threads, as manufactured by Pittsburgh Standard, Triangle or Allied.
- H. Rigid Aluminum Conduit: Pittsburg Standard, Triangle or Allied.
- I. Nonmetallic Conduits: Schedule 40 PVC as manufactured by Carlon, Krayloy or Pittsburg Standard.
- J. EMT: Pittsburg Standard, Triangle or Allied.
- K. Flexible Metal Conduit: International, AFC, or Alflex.
- L. Liquid Tight Flexible Conduit: Presheathed galvanized steel Anaconda Type UA, Electric-Flex Type LA, Appleton, or AFC.

2.2 CONDUIT FITTINGS

- A. Rigid Steel Conduit: ANSI/NEMA FB1.
- B. EMT: Steel compression type in new construction or where exposed to weather or dampness. Set-screw type fittings not acceptable. Die cast is not acceptable. Provide connectors with insulated throats
- C. Flexible Metal Conduit: ANSI/NEMA FB1.
- D. Liquid Tight Flexible Metal Conduit: ANSI/NEMA FB1.
- E. Nonmetallic Conduit: NEMA TC 3.
- F. Miscellaneous Fittings:
 - 1. Conduit Bodies: "Mogul" size conduit bodies for conduits are larger than or equal to 1 1/2" and terminate at equipment having a ground bus..
 - 2. Grounding Bushings:
- G. Threaded Rigid Conduit: Appleton Type "GIB", Crouse-Hinds Type "GLL" or Thomas & Betts 3800 series threaded, grounding type insulated metallic bushing, in combination with one exterior and one interior locknut.
- H. EMT: O.Z. Gedney Type SB.

1. Expansion Fittings: O.Z. Gedney Type "AX" or "EX" with bonding jumper.
2. Sealing Fittings: Standard conduit bodies with sealing materials or compound as recommended by Manufacturer.
3. Hubs: Appleton "HUB" or "HUB-U" Series or Thomas & Betts "370" Series.
4. Unions: Appleton Type "EC" or Thomas & Betts "Erickson coupling".
5. Plastic Bushings:

- I. Threaded: Equal to Thomas & Betts 222 series.
- J. Threadless: Equal to Thomas & Betts TRIB series.

2.3 CONDUIT ACCESSORIES

- A. Fasteners: Hot-dipped galvanized one-hole straps or other Owner approved methods. No plastic anchors, tie-wires or tie wraps will be accepted.
- B. Pull Lines: Jet line #232.
- C. Sleeve Penetration Sealant: Refer to Division 07.
- D. Underground Warning Tape: 6" wide, red black letters, continuous message: "Caution - Buried Electrical Line".
- E. Floor, Ceiling and Wall Plates: Provide chrome-plated brass escutcheons around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas, sized to fit conduit and securely locked in place.

2.4 WIREWAY

- A. Manufacturers: Square D, Hoffman, or Wiegmann.
- B. Description: General purpose or Raintight type wireway.
- C. Knockouts: Manufacturer's standard.
- D. Minimum Size: 6 x 6 inch length, as indicated on the drawings.
- E. Cover: Hinged cover.
- F. Connector: Slip in.
- G. Finish: Rust inhibiting primer coating with gray enamel finish.

2.5 BOXES

- A. Manufacturers: Raco, Steel City, or Appleton.
- B. Pull Boxes: Galvanized steel, sized in accordance with the National Electrical Code. Use standard outlet boxes for junction and pull boxes 45 cubic inches in size and smaller. Use cabinets, as specified below, for pull boxes larger than 45 cubic inches.
- C. Outlet Boxes:
 1. Galvanized steel, at least 2-1/8" inches deep, and of sufficient size to accommodate wiring devices.
 2. Handy boxes and single gang switch boxes will not be accepted.
 3. Allow 2.25 cubic inches per No. 12 conductor in each outlet box.

4. Where 1" conduit terminates in outlet box, provide 4-11/16" square deep box.
 5. Furnish plaster rings where required.
 6. Conform to National Electrical Code Table 370-6.
 7. Extension boxes are not allowed.
 8. Outlet boxes in walls shall be supported between two studs.
- D. Outlet Boxes for Wall Brackets and Overhead lights : 4" square or octagon galvanized boxes, 2-1/8" deep, depending upon the number of conductors. Provide 3/8" fixture studs through back of box where required for mounting fixtures. Furnish plaster rings where required.
- E. Outlet Boxes in Masonry Walls: Sheet steel outlet boxes made specifically for masonry walls, in one to five gang widths, Raco Cat. No. 696 through 699. Single gang switch boxes and handy boxes will not be accepted.
- F. Cabinets:
1. Construction: NEMA 250, Type 1, 3R, or 4 steel enclosure as indicated.
 2. Covers: Secured by screws.
 3. Enclosure Finish: Manufacturer's standard gray baked enamel or stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Locate all proposed underground utilities in accordance with Division 02.
- B. Perform all excavation, trenching and backfill in accordance with Division 02.

3.2 CONDUIT INSTALLATION

- A. Concealed: Run conduit concealed in all areas unless otherwise indicated or specified. Concealed conduits are those hidden from sight as in hung ceilings, walls, chases, furred spaces or trenches.
- B. Exposed: Run conduit exposed, parallel or perpendicular with building lines, in all mechanical rooms and chases and where indicated on the drawings.
- C. Joints: Cut all joints square, ream smooth, and draw up tight.
- D. Run concealed conduit as direct and with largest radius bends as possible. Run exposed conduit parallel with, or at right angles to, the lines of the building. Make all bends with standard conduit elbows or bend conduit to not less than equivalent radius. All bends shall be free from dents or flattening. Use no more than the equivalent of four quarter bends in any run between terminals and cabinets, or between outlets and junction or pull boxes.
- E. Use approved condulets in lieu of conduit elbows where installation conditions and appearance warrant their use. Make conduit joints with approved couplings and unions.
- F. Run conduits continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Secure conduits to all boxes in such manner that each system is electrically continuous throughout.
- G. Provide double lock nuts and bushings for all conduits terminated on hubs. Use of running threads is prohibited.

- H. Support all conduits at a maximum spacing of 10 feet, in accordance with NEC Art. 346-12 and 348-12. Support conduits above removable ceilings from the building structure as high as practicable so as not to restrict ceiling panel removal.
- I. Spring steel Caddy straps are not permitted. Provide mineral lack straps or one-hole straps only.
- J. Provide pull boxes for telephone and low voltage (example - Fire Alarm) conduit systems after four right angle bends and at intervals not exceeding 70 feet. Locate boxes in accessible locations. Do not use pull boxes at 90° bends.
- K. Install each complete conduit system prior to cover-up and before any conductors are drawn in.
- L. Terminate 1-1/2" conduits and larger at switchboards, motor control centers and panelboards with grounding bushings.
- M. Install hubs at panel top entries in all wet and damp locations, including fire pump controllers.
- N. 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.
- O. 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. The following exceptions permitted:
 - 1. EMT:
 - a. In sizes up to and including 1-1/2 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, dry wall partitions and exposed where 6 feet above the floor. EMT may not be used outside, in concrete, underground, in crawl spaces, in masonry walls, in locations likely to be damp, in electrical rooms subject to mechanical damage due to future installation, or exposed within 6 feet of the floor. EMT shall not be used for medium voltage circuits.
 - b. Where used for feeder circuits receptacle branch circuits and motor branch circuits EMT shall also contain a NEC grounding conductor.
 - c. All conduits shall be concealed in walls or ceilings unless otherwise noted.
 - d. PVC (underground use only):
 - e. Install PVC schedule 40 conduit where direct buried in earth.
 - f. Type DB, Utility Duct, encased in concrete.

- g. Liquid-tight:
 - h. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Install external ground wire on flexible conduit with grounding bushings. Maximum length shall be 6 feet minimum of 2 feet.
 - i. Flexible Metal Conduit:
 - j. 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 3/4; and minimum size shall be 3/8 inch for lay-in light fixture whips.
- P. Ground and bond all conduits in accordance with section 26 05 26.
- Q. 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..
- R. Identify all conduits in accordance with section 26 00 00. Install underground conduits with sealing glands at the point where conduits enter the building to prevent water seepage into the building.
- S. Fittings shall be approved for grounding purposes or shall be jumpered with copper grounding conductors of appropriate ampacity. Leave termination of such jumpers exposed.
- T. Install expansion fittings in metal and PVC conduit as follows:
- 1. Conduit Crossing Building Expansion Joints:
 - a. EMT all sizes.
 - b. RMC all sizes.
 - c. PVC all sizes.
 - d. Conduits entering environmental rooms and other locations subject to thermal expansion and as required by NEC.
 - e. Unless expansion fitting has an integral bonding braid, as in Crouse-Hinds Type XC, a green insulated grounding conductor shall be pulled in the conduit. Both ends of these green grounding conductors shall be accessible for inspection.

3.3 CLEANING AND PULL LINES

- A. Clean and swab conduit runs to remove foreign matter and moisture prior to pulling in wire and cable. Clean boxes of concrete, mortar, and other foreign matter.
- B. Provide pull lines for full length of all active and empty conduits.
- C. Provide 200 lb. nylon cord full length in empty conduit

3.4 BOX INSTALLATION

- A. Wall Installation: Where outlets are indicated adjacent to each other, mount in a symmetrical pattern, with tops of the boxes at the same elevation. Where outlets are shown adjacent to each other with different mounting heights, mount in a vertical symmetrical pattern.
- B. Verify final location of each box with the owner's representative on the job site before rough-in. Coordinate locations with equipment furnished under other Divisions and by the Owner.
- C. Noise Transmission Prevention: Do not connect boxes back to back with a nipple.
- D. Extension rings are not permitted. Calculate boxes for new construction.
- E. Mounting: Rigidly mount boxes. Provide appropriate covers and all mounting hardware. Mount recessed boxes so box front is flush with finished wall or ceiling. Provide plaster rings as needed. Close all unused knock-outs.
- F. Mounting Heights: Unless indicated otherwise, mount boxes as specified below:
 - 1. Wall Switch: 48 inches above finished floor.
 - 2. Convenience Receptacle: 18 inches above finished floor.
 - 3. Convenience Receptacle: 6 inches above counter horizontal.
 - 4. Dimmer: 48 inches above finished floor.
 - 5. Telephone/Data Outlets: 18 inches above finished floor.
 - 6. Outlet for Wall Telephone: 48 above finished floor.

3.5 CONDUIT AND BOX IDENTIFICATION

- A. Identify conduits and outlet boxes by stencil and paint or stick-on labels.
 - 1. Conduits: Mark circuit number on each side of a wall, each side of bends and a minimum every 20 feet of horizontal run.
 - 2. Boxes: Mark covers.
- B. Box Colors: Provide color coding per Specification 26 05 53

3.6 PENETRATION SEALS

- A. Seal all penetrations through fire rated floors in accordance with Division 07 and as required by Article 300-21 of the National Electrical Code.

END OF SECTION

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Nameplates and tape labels
- B. Wire and cable markers
- C. Conduit color coding and labeling

1.2 REFERENCES

- A. NFPA 70 – National Electrical Code (latest edition)

1.3 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 05 00, 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

2.1 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.
- B. 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.
- C. Conduit Labels (5 kV and 15 kV Conduits Only): 2-inch black letters on yellow background reading "DANGER - 12,470 VOLTS" or "DANGER - 4,160 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.
- D. Conduit labels (600V and below): Mark circuit number on conduit at each side of a wall, each side of bends and a minimum every 20 feet of horizontal run

- E. Warning labels: Provide warning labels with black lettering on red background with a minimum of 3/8" lettering.
- F. Tape Labels: Embossed adhesive tape, with minimum 3/8-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.
 - 1. White letters on black background for normal power.
 - 2. White letters on red background for emergency/standby power.
 - 3. White letters on orange background for UPS power.
- G. J-Box and Cover plate Voltage Labels: Black stenciled letters 3/8" high. Adhesive back tapes may be used if a clear tape is applied over the label for protection.
- H. Device Plates: Engrave device plates with 3/8-inch letters.

PART 3 - EXECUTION

3.1 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.

3.2 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:

Conductor	System Voltage			
	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 IG	Green N/A	Green Green w/Yellow	Green Green w/Yellow	Green N/A

3.3 NAMEPLATE ENGRAVING SCHEDULE

- A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.
- 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 primary and secondary voltages, primary source, and secondary load and location.
- 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, voltage and bus rating.

3.4 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	Yellow
Clock	Fluorescent Violet
U.P.S.	Orange

**Security shall include, but not be limited to, the following systems:

- Card Access
- Duress Alarms
- Perimeter Door Alarms
- CCTV

END OF SECTION

SECTION 26 13 20

HIGH RESISTANCE GROUNDING SYSTEM – MEDIUM VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. An HRG (High Resistance Grounding) System shall be provided to ground the wye point of generators and limit the flow of ground fault current. Ground fault current above a threshold level shall alarm but shall not shutdown generators.

1.2 Submittals – for Review/approval

- A. The following information shall be submitted:
 - 1. Master drawing index
 - 2. Front view elevation
 - 3. Floor plan
 - 4. Top view
 - 5. Single line
 - 6. Schematic diagram
 - 7. Nameplate schedule
 - 8. Component list
 - 9. Conduit entry/exit locations
 - 10. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 - d. Basic impulse level for equipment over 600 volts
 - 11. Major component ratings including:
 - a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
 - 12. Cable terminal sizes.
 - 13. Descriptive bulletins
 - 14. Product data sheets.

1.3 Submittals – for RECORD PURPOSES

- A. The following information shall be submitted for record purposes:
 - 1. Final as-built drawings and information for items listed in the above paragraph.
 - 2. Wiring diagrams
 - 3. Certified production test reports
 - 4. Installation information including equipment anchorage provisions

1.4 Qualifications

- A. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.5 Delivery, Storage and Handling

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.
- B. HRG (High Resistance Grounding) system assembly shall be designed to be shipped by truck. Indoor units shall be bolted to skids. HRG system assembly shall be equipped to be handled by crane. Where cranes are not available, it shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.
- C. Equipment being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors, indoor equipment shall be covered and heated, and outdoor equipment shall be heated.

1.6 Operation and Maintenance Manuals

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

PART 2- PRODUCTS

2.1 MANUFACTURERS

- A. Cutler-Hammer
- B. Post Glover
- C. Powell Electric

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

- A. The assembly shall be suitable for maximum service voltage and the type of power system as indicated on the drawings.
- B. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source.
- C. The assembly shall be UL approved and supplied with the UL label.

2.3 CONSTRUCTION

- A. The assembly shall consist of a free standing front accessible NEMA 1 enclosure. Side and rear access is not available. Front and rear access is required. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

- B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to a concrete pad. Base of assembly shall be suitable for rolling directly on pipes without skids
- C. The assembly shall include a grounding transformer grounding resistor with tapes, pulsing resistor, pulsing contactor, current transformer, overcurrent relay, primary fuse, secondary circuit breaker, controls and alarms as herein specified or as required.
- D. Each vertical steel unit forming part of the assembly shall be a self-contained housing having an instrument compartment and a resistor compartment. The control compartment shall be segregated from the grounding resistor compartment by means of steel barriers or, the grounding resistor assembly shall be a separately mounted component furnished in its own ventilated enclosure.

2.4 BUS

- A. A 1/4-inch x 2-inch copper ground bus shall be firmly secured to the assembly. Provide terminals for connection of system grounding conductors, suitable for #8 AWG to 500 kcmil, copper.

2.5 WIRING/TERMINATIONS

- A. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminals shall be provided. One control circuit disconnect device shall be provided in each control circuit. Switchgear secondary wire shall be #14 AWG, type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.
- B. The Neutral terminal for a wye connected system shall be suitable for a 4AWG to 500 kcmil 8kV power cable. The power cable (supplied by customer) shall enter the HRG enclosure from the top.

2.6 METERING AND CONTROLS

- A. Provide a separate control compartment with front hinged door that includes the following:
 - 1. A switchboard type digital electronic ground current ammeter, 1% accuracy, 0 to 10A AC range.
 - 2. System control selector switch with PULSE/NORMAL/TEST positions. Switch shall spring-return to NORMAL from the TEST position.
 - 3. Reset control selector switch with AUTO/MANUAL/RESET positions. Switch shall spring-return to MANUAL from RESET position. The AUTO position shall cause the ground fault relay to automatically reset when a ground is no longer detected. The MANUAL position shall cause the ground alarm relay to latch and remain latched until the selector is moved to the RESET position by the operator.
 - 4. A green lamp to indicate that the system is in normal condition, a red lamp to indicate that a ground fault has been detected and a white lamp that flashes at the same time as the pulsing contactor, at an adjustable rate of 3 to 60 pulses per minute.
 - 5. An instruction nameplate that provides the operator with a step-by-step procedure for operating the controls.
 - 6. A rating nameplate that states the maximum ground current, maximum pulse current and duty rating of the equipment at maximum current levels.

7. An alarm horn with an alarm silence pushbutton and re-alarm timer. The horn shall be a heavy-duty, high-decibel type, adjustable from 78 to 103 db. Alarm silence control shall reset when ground relay is reset. Alarm shall automatically re-sound at the end of a 2- to 48-hour field-settable time interval if alarm has been silenced but ground fault still exists. Re-alarm timer shall not be defeatable via any control device.
- B. Provide the following control devices and features:
1. Two normally open and two normally closed ground fault alarm contacts each rated 10 amps at 240 volts AC 24 volts DC.
 2. A test circuit shall be included to functionally test all controls of the fault indication and pulsing circuitry. The test shall be inhibited if the system is sensing a fault.
 3. A pulsing contactor, controlled by an adjustable recycle timer, allowing a momentary increase of approximately 4 amperes above ground current.
 4. Terminals shall be supplied to accommodate 120V 60 Hz control power supply circuits.
 5. Dead-front pull-out type fuse block with fuses for control power disconnect.
 6. A tapped grounding resistors with taps wired out to a convenient front accessible terminal block. Taps shall provide 3 to 6 amperes of ground current in 1 ampere increments. Resistors shall be heavy-duty industrial type, edge wound design. Each resistor element shall have a stamped steel rating nameplate. The resistor assembly shall be interconnected with suitable wire size as required for the circuit current.
 7. All control wiring shall be #14 AWG type SIS minimum.
 8. Provide detailed schematics that accurately and completely describes the control and grounding circuits. All wire designations, terminal points, control device, and selector switch contact developments shall be shown. The schematic and the accompanying wiring diagrams shall be amended as required after final testing at the factory. An as-built copy of the schematic, wiring diagrams and material list shall be packed with the unit prior to shipment. Provide a drawing pocket secured by screws or weldment for drawing storage within the assembly.
 9. A single phase distribution type transformer of proper kVA and voltage rating shall be connected from power system neutral to ground, with the required resistor assembly inserted in the secondary circuit of that transformer. A primary, current limiting fuse shall be provided for the single phase distribution type transformer.

2.7 NAMEPLATES

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all control devices as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum. Furnish master nameplate giving HRG System designation, voltage and ampere ratings, manufacturer's name, catalog number, and general order number.
- B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.8 FINISH

- A. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal

and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray.

PART 3 - EXECUTION

3.1 Factory Testing

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with latest version of ANSI and NEMA standards.
 - 1. Completely test the high-resistance grounding system for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment.
 - 2. The wiring and control circuits shall be given a dielectric test of 1500 volts for one (1) minute between live parts and ground in accordance with ANSI C37.20.2.
- B. Provide certified test reports of all standard production tests to the Owner.

3.2 Field Quality Control

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The Contractor shall provide eight (8) copies of the manufacturer's field start-up report.

3.3 Manufacturer's Certification

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide copies of the manufacturer's representative's certification.

3.4 Training

- A. The Contractor shall provide a training session for up to ten (10) Owner designated representatives (ODR) for one normal workday at a jobsite location determined by the ODR.
- B. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, and other major components.

3.5 Installation

- A. The Contractor shall install all equipment per the manufacturer's recommendations and contract drawings.
- B. All necessary hardware to secure the assembly in place shall be provided by the contractor.

3.6 Field Adjustments

- A. The relays shall be set in the field by the Contractor in accordance with settings designated by the manufacturer.

END OF SECTION

SECTION 26 22 13

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section includes enclosed dry type distribution transformers rated 600 volts and less, sizes up to 500 kVA.
 - 1. Dry type Two-Winding transformers.
 - 2. Dry type Buck and Boost transformers.
 - 3. Dry type Shielded Isolation transformers.
 - 4. Dry type, K-rated transformers.

1.2 REFERENCES

- A. NEMA ST 1 - Specialty Transformers (Except General Purpose Type)
- B. NEMA ST 20 - Dry Type Transformers for General Applications
- C. IEEE C57.12.01 - General Requirements for Dry-Type Distribution and Power Transformers.
- D. IEEE C57.12.91 - Test Code for Dry-Type Distribution and Power Transformers
- E. IEEE C57.96 – Guide for Loading Dry-Type Distribution and Power Transformers
- F. IEEE Std. 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
- G. UL 506 – Specialty Transformers
- H. UL 1561 - Dry Type General Purpose and Power Transformers
- I. NEMA TP 1 – Guide for Determining Energy Efficiency for Distribution Transformers
- J. NEMA TP 2 – Standard Test Method for Measuring the Energy Consumption for Distribution Transformers

1.3 SUBMITTALS

- A. Provide submittals in accordance with Basic Electrical Requirements and Division 01 for submittal requirement.
- B. Submit manufacturer's data on dry type transformers, vibration isolators and accessories.
- C. Include outline and support point dimensions of enclosures and accessories; unit weight; voltage; kVA; impedance ratings and characteristics; loss data; efficiency at 25, 50, 75 and 100 percent rated load; sound level; tap configurations; insulation system type, and rated temperature rise.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store transformers in a clean and dry space and protected from weather in accordance with manufacturer's instructions. Cover ventilating openings to keep out dust.
- B. Transformer shall not be used as work tables, scaffolds or ladders.
- C. 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.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Transformers shall be of dry type complying with the design function requirements of the project. Design characteristics shall be as noted in manufacturer's submittal data.
- B. Provide barrel type coils vacuum impregnated with high grade insulating varnish, non-hydroscopic thermo-setting type.
- C. Furnish copper windings, continuous without splice.
- D. Use non-aging silicon steel cores held together with steel channels or angles, with low flux density, quiet operating, and vibration isolated from enclosure and support channels.
- E. All transformers shall be designed, manufactured, and tested in accordance with all the latest applicable ANSI, NEMA, IEEE and UL standards, and shall be UL listed and bear the UL label.

2.2 DRY TYPE TWO-WINDING TRANSFORMERS

- A. Acceptable manufacturers
 - 1. Square D
 - 2. Cutler-Hammer
 - 3. General Electric Company
- B. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 05 00, and Division 01 for substitution requirement.
- C. Dry type transformers shall be NEMA ST 20; factory-assembled, air cooled dry type transformers; ratings as shown on the Drawings.
- D. Insulation system and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA as follows:

kVA Rating	Insulation Class (degree C)	Temperature Rise (degree C)
1-15 kVA	185	115
25-500 kVA	220	115

- E. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degree ambient.
- F. Winding Taps, Transformers 15 kVA and Less: Two 5 percent below rated voltage, full

capacity taps on primary winding.

G. Winding Taps, Transformers 25 kVA and Larger: Two 2.5 percent above rated voltage and four 2.5 percent below rated voltage, full capacity taps on primary.

H. Sound Levels: Maximum sound levels are as follows:

kVA Rating	Sound Level
0-9	40 db
10-50	45 db
51-150	50 db
151-300	55 db
301-500	60 db

I. Basic impulse level shall be 10 KV.

J. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

K. Transformers 75 kVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA shall be floor mounted.

L. Enclosure shall be NEMA Type 2 or as shown on the Drawings. Provide lifting eyes or brackets.

M. Nameplate on transformer shall include transformer connection data, kVA ratings, impedance, and overload capacity based on rated allowable winding temperature rise. Identify primary and secondary voltages.

N. Isolate core and coil from enclosure using vibration absorbing mounts.

O. Provide identification nameplate in accordance with Section 26 05 53.UT Electrical Identification.

2.3 DRY TYPE BUCK AND BOOST TRANSFORMERS

A. Acceptable manufacturers

1. Square D
2. Cutler-Hammer
3. General Electric Company

B. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 05 00, and Division 01 for substitution requirement.

C. Dry Type Buck and Boost Transformers shall be NEMA ST 1; factory-assembled, dry type two winding buck and boost transformers; ratings as shown on the Drawings.

D. Insulation system and average winding temperature rise for rated kVA as follows:

kVA Rating	Insulation Class (degree C)	Temperature Rise (degree C)
0.25-2 kVA	185	115
3-7.5 kVA	185	115

E. Transformers shall be suitable for wall mount.

F. Enclosure shall be NEMA Type 3R or as shown on the Drawings.

DRY TYPE TRANSFORMERS

- G. Nameplate shall include transformer connection data.

2.4 DRY TYPE SHIELDED ISOLATION TRANSFORMERS

- A. Acceptable manufacturers
 - 1. Square D
 - 2. Cutler-Hammer
 - 3. General Electric Company
- B. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 05 00, and Division 01 for substitution requirement.
- C. Dry Type Shielded Isolation Transformers shall be NEMA ST 20; factory-assembled, air cooled dry type shielded isolation transformers; ratings as shown on the Drawings.
- D. Insulation system and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA shall be as 2.2 C.
- E. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degree ambient.
- F. Winding Taps, Transformers 15 kVA and Less: Two 5 percent below rated voltage, full capacity taps on primary winding.
- G. Winding Taps, Transformers 25 kVA and Larger: Two 2.5 percent above rated voltage and four 2.5 percent below rated voltage, full capacity taps on primary.
- H. Maximum sound levels are as 2.2 G.
- I. Basic Impulse Level shall be 10 KV.
- J. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- K. Transformers shall be supplied with quality, full width electrostatic shields in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits:

- 1. Common mode noise attenuation:

Frequency	Attenuation
0 - 1.5k Hz	120 db
1.5 -10k Hz	90 db
10 - 100k Hz	65 db
100k – 1M Hz	40 db

- 2. Transverse mode noise attenuation:

Frequency	Attenuation
1.5 -10k Hz	52 db
10 - 100k Hz	30 db
100k – 1M Hz	30 db

- L. Provide electrostatic shield between the primary and secondary winding and grounded to the transformer core.

- M. Transformers 75 kVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA shall be floor mounted.
- N. Enclosure shall be NEMA Type 2 or as shown on the Drawings. Provide lifting eyes or brackets.
- O. Nameplate on transformer shall include transformer connection data, ratings, impedance, and overload capacity based on rated allowable winding temperature rise. Identify primary and secondary voltages.
- P. Isolate core and coil from enclosure using vibration absorbing mounts.
- Q. Provide identification nameplate in accordance with Section 26 05 53.UT Electrical Identification.

2.5 DRY TYPE, K-RATED TRANSFORMERS

- A. K-rated transformers shall be NEMA ST 20; factory-assembled, air cooled dry type transformers meeting all the requirements as specified under paragraphs 2.2 and 2.4 of this Section; ratings as shown on the Drawings.
- B. Impedance range shall be 3 percent to 5 percent with a 2 percent minimum reactance in order to reduce neutral current when supplying loads with large amount of third harmonic current.
- C. Transformers shall be UL listed and labeled for K-4 or K-13; ratings as shown on the Drawings.
- D. Three-phase transformer secondary neutral terminal shall be sized for 200 percent of the rated secondary phase current.

PART 3 - EXECUTION

3.1 INSPECTION

- A. 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.

3.2 INSTALLATION

- A. Install dry type transformers as indicated, in accordance with the applicable requirements of the NEC and the National Electrical Contractors Association's "Standard of Installation".
- B. Check for damage and tight connections prior to energizing transformer.
- C. Measure primary and secondary voltages and make appropriate tap adjustments.
- D. Set transformer plumb and level.
- E. Use flexible liquid-tight conduit, 2 ft. minimum length, 6 ft. maximum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

- F. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
 - 1. For floor or roof transformer installations, use one pad type Korfund Elasto-Grip, waffle, or equal, at each corner of the transformer, sized for load of 50 lbs./sq. in.
 - 2. For wall hung transformer installations, use spring type Korfund Series P, or equal. Provide sound pads at each corner of the transformer, sized for 1/2 inch deflection.
- G. Avoid mounting transformers in areas where tend to amplify noises, such as stairways, hall areas, and corners near ceilings. Avoid where possible, nearby reflecting object or enclosure that might resonate or echo.
- H. Ground transformers in accordance with Section 26 05 26 Grounding and NEC requirements.

END OF SECTION

SECTION 26 24 16
BRANCH CIRCUIT PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 REFERENCES

- A. NECA 1-2000 – Standard Practices for Good Workmanship in Electrical Contracting.
- B. NEMA AB 1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- D. NEMA PB 1 - Panelboards.
- E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- F. NFPA 70 - National Electrical Code. IEEE C62.41-1991 - IEEE Recommended Practice on Surge Voltage in AC Power Circuits.
- G. ANSI/IEEE C62.45-1987 - IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
- H. UL 1449 Third Edition - Standard for Transient Voltage Surge Suppressors.
- I. UL 1283 - Standard for Electromagnetic Interference Filters.

1.3 RELATED SECTIONS

- A. Section 26 05 00 –Electrical General Provisions.
- B. Section 26 05 26 – Grounding.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All devices shall be fully rated. Series rated devices are not allowed.

2.2 MANUFACTURERS

- A. Square D.
- B. General Electric.
- C. Cutler-Hammer.

2.3 BRANCH CIRCUIT PANELBOARDS

- A. Construction: NEMA PB1, circuit breaker type, NEMA 1 enclosure unless indicated otherwise. Factory installed knockouts are not allowed.
- B. Rating: As indicated on drawings.
- C. Bus: Tin plated copper, ratings as indicated. Provide copper ground bus in each panelboard. Use 1000 amps per square inch for all busses.
- D. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents.
- E. Short Circuit Rating: Provide minimum integrated short circuit interrupting capacity unless noted higher on the drawings.
 - 1. 240 Volts and Below: 10,000 amperes RMS symmetrical.
 - 2. Above 240 Volts: 14,000 amperes RMS symmetrical.
- F. Molded Case Circuit Breakers:
 - 1. NEMA AB 1, bolt-on type, thermal magnetic trip circuit breakers, with common trip handle for all poles.
 - 2. Provide circuit breakers UL listed as Type SWD for lighting circuits.
 - 3. Provide circuit breakers UL listed as Type HID for circuits serving high intensity discharge luminaires.
 - 4. Provide UL Class A ground fault interrupter circuit breakers where scheduled.
 - 5. Do not use tandem circuit breakers.
 - 6. Breakers feeding 120 volt shunt trip circuits shall be provided with breaker handle locking devices.
 - 7. Provide maximum number of circuit breakers for which the panelboard is configured.
- G. Cabinet Front: Surface cabinet front with concealed trim clamps, concealed hinge, "door-in-door" construction with flush lock. Key all locks alike.
- H. Finish: ANSI 61 gray enamel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1.
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Ground and bond panelboards under the provisions of Section 26 05 26.
- D. Height: 6 ft to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- E. Provide filler plates for unused spaces in panelboards.

- F. Provide typed circuit directory, matching the actual circuit breaker arrangement, for each branch circuit panelboard under provisions of Section 26 05 00. Revise directory to reflect circuiting changes required to balance phase loads. All panelboards shall be furnished with metal directory holders.
- G. Provide engraved plastic nameplates under the provisions of Section 26 05 00.
- H. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits: One 3/4 inch empty conduit for every three spare or space circuits. Identify each conduit as SPARE.
- I. Provide compression lugs to accept service feeders.
- J. Provide field drilled holes in all panelboards in lieu of factory installed knockouts to ensure mechanical continuity and a solid grounding connection.

3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 01.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

3.3 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.
- C. SCHEDULES: Refer to the Drawings.

END OF SECTION

SECTION 26 32 14

NATURAL GAS ENGINE GENERATOR PACKAGE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish one packaged natural gas rich-burn spark-ignited reciprocating engine-generator system, including the following. This generator will be connected to new 5kV paralleling switchgear installed under another project. There will three generators total connected to this switchgear. The one new generator specified here and two existing generators.
 - 1. Packaged engine generator set with PCC 3.3 controller to allow for paralleling with two other generators with PCC 3.3 controllers. The two existing generator will have their existing controllers replaced with PCC 3.3 controller under the switchgear replacement project.
 - 2. Exhaust silencer and fittings.
 - 3. Fuel accessories, including the gas pressure regulator.
 - 4. Remote annunciators.
 - 5. Starting batteries, cables, batteries box, and accessories

1.2 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.3 REFERENCES

- A. NEMA 250 – Enclosures for Electrical Equipment (1000 volts maximum)
- B. NEMA MG1 – Motors and Generators
- C. NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines 2006.
- D. NFPA 54/ANSI Z223.1 – National Fuel Gas Code 2006.
- E. NFPA 70 – National Electrical Code 2005
- F. NFPA 110 – Standard for Emergency and Standby Power Systems 2005.

1.4 SYSTEM DESCRIPTION

- A. The packaged natural gas rich-burn spark-ignited reciprocating engine-generator system will be used by the University as an emergency and standby power source. The packaged engine-generator system shall be a coordinated assembly of compatible components, and comply with NFPA 110 Level 1 requirements for an emergency power supply system. The packaged system will operate in parallel with two existing units of similar size.

- B. System Capacity: 750 kW at 4.16kV, 60 HZ and at 1,500 feet or less above sea level with an ambient temperature between 0 degree and 104 degrees F.
- C. The generator set, and auxiliary and accessory components necessary for proper operation, must fit in available space in the Medical School Building Room P.102D with proper operating and maintenance clearances and free air space.

1.5 SUBMITTALS – SUBMIT A MINIMUM OF EIGHT COPIES OF ALL REQUIRED SUBMITTALS.

- A. Information:
 - 1. Manufacturer and model of the packaged engine-generator system.
 - 2. Manufacturer's standard product information for the engine-generator system, with the following information clearly marked or highlighted:
 - a. Generator system standby rating in kW/kVA at the specified conditions.
 - b. Generator system dry weight.
 - c. Dimensioned outline plan and elevation drawings of the engine-generator system.
 - d. Engine specifications.
 - e. Required natural gas supply pressure and fuel supply line inlet size.
 - f. Exhaust flow and temperature at rated kW, with maximum allowable backpressure and exhaust outlet size.
 - 3. Fuel consumption rates at various loads.
 - 4. Ventilation and combustion air requirements.
 - 5. Radiator sizing data and heat balance data.
 - 6. Manufacturer's standard product data for the alternator, with the following information clearly marked or highlighted:
 - a. Rating in kW at 105 degrees C Continuous (Rise by Resistance Method, Mil-Std-705) and 130 degrees C Standby (Rise by Resistance Method, Mil-Std-705); 60 HZ; 1800 RPM; 0.8 power factor.
 - b. Subtransient reactance in per unit or percent.
 - c. Insulation system class.
 - d. Typical motor starting kVA vs. % voltage dip chart or table.
 - e. Line-Line Harmonic Maximum Total (Distortion Factor) per Mil-Std-705B Method 601.4a.
- B. Product Data:
 - 1. Detailed data on engine-generator system features, components, accessories, ratings, and performance.
 - 2. Thermal damage curve for generator.
 - 3. Time-current characteristic curves for generator protective device.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Detailed dimensioned outline plan and elevation drawings of engine-generator set and other components.
 - 2. Vibration Isolation Details: Basis for selection of vibration isolation products. Specify requirements for vibration isolation bases.
 - 3. Wiring Diagrams and Schematics: Power, signal, and control wiring.
- D. Qualification Data: Manufacturer shall have been in the business of packaging engine-generators for commercial and institutional emergency and standby power systems for more than ten years.
- E. Certified summary of prototype-unit test report.

- F. Certified Test Reports: For components and accessories that are equivalent, but not identical to those tested on prototype unit.
- G. Factory Test Reports:
 - 1. Report of factory test on unit to be shipped for this project, showing compliance with specified requirements.
 - 2. Report of sound generation.
 - 3. Report of exhaust emissions showing compliance with applicable regulations for units installed in Houston, Harris County, Texas.
 - 4. Field quality-control test reports.
- H. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.
- I. Operation and Maintenance Data: Include product data and shop drawings.
 - 1. List of tools and replacement items recommended for storage at the project site for emergency repairs. Include part and drawing numbers, current unit prices, and source of supply.
 - 2. Copies of inspection and test reports.
 - 3. Component installation, operation, and maintenance manuals.
- J. Special Warranty: Submit the manufacturer's warranty statement for the packaged engine-generator system.
- K. Rigging Diagram: Submit a rigging diagram indicating location and lifting capacity of each lifting attachment and engine-generator center of gravity.

1.6 WARRANTY

- A. Special Warranty: Warrant the packaged engine-generator system to be free from defects in materials and workmanship for a period of two years or for 1500 hours of run time, whichever is less, from the date of installation, beginning with substantial completion and beneficial use.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in packaged engine-generator systems.
- B. Supplier Qualifications: Authorized distributor of engine-generator manufacturer with staffed service facilities within 50 miles of the Texas Medical Center in Houston. Manufacturer's recommended repair parts stocked at the service facility. Repair service available 24 hours a day/365 days per year.

1.8 MAINTENANCE SERVICE

- A. Submit prospective contract provisions and contract cost for service and maintenance of packaged engine generator system for one year from the date of installation, beginning with substantial completion and beneficial use. Maintenance tasks should be provided in accordance with the manufacturer's recommendations and NFPA 110 quarterly and semi-annual maintenance tasks, including annual maintenance at the end of the one-year period.
- B. Include maintenance service contract as a separate amount in proposal. The maintenance agreement may be rejected independently of the base proposal for the engine-generator system.

1.9 ADDITIONAL MATERIALS

- A. Furnish additional materials described below that match products installed. Enclose with protective packaging for storage, with package contents identified with external labels.
 - 1. Fuses: One for every 10 of each type and rating, but not less than two of each.
 - 2. Indicator Lamps: Two for every six of each type used, but not less than two each.
 - 3. Filters: Two sets each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cummins – No Substitutions – There are currently two existing Cummins 800KW, 4.16kV generators on site. The new generator will be paralleled with the two existing generators and thus all generators need to be from the same manufacturer.

2.2 NATURAL GAS ENGINE

- A. Type: 1800 RPM; 4-cycle; rich-burn; spark-ignited; reciprocating 16V; turbo-charged and after-cooled.
- B. Rating: Sufficient to operate as a standby power source at rated load at specified elevation and ambient limits with all accessories attached. 1,098 BHP minimum power at rated RPM. 3067 CI displacement minimum.
- C. Fuel System: Suitable for natural gas supplied by the local distribution company to retail customers in the Texas Medical Center. Building natural gas distribution to the engine-generator system will be 5 PSI or less, with the exact pressure range identified by the University prior to shop drawing submittal production.
- D. Governor: Isochronous type to maintain engine speed within 0.5 percent, steady state, no load to full load, with maximum speed change of plus or minus 2 percent. Governor shall be electronic type. Generator manufacturer shall supply governor control unit for mounting at generator.
- E. Synchronization Controller – Controller shall be located at generator control panel. This generator will be paralleled with two other Cummins generators. All paralleling function shall be controlled via the generator controllers.
- F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer. Provide individual indicating light for each function.
- G. Engine Starting: Cycle cranking function, non-adjustable and automatic for a 15 second duration and in accordance with manufacturer's instructions. Include provisions for a remote starting control circuit, with a HAND-OFF-AUTO selector switch on the engine-generator control panel.
- H. Skid-Mounted Radiator: Closed-loop radiator system including belt-driven pusher fan, coolant pump, and thermostat temperature control. The radiator shall be shipped on the skid with the engine-generator as a complete assembly.
- I. The cooling system shall be rated for full load operation. The cooling system shall be rated by the manufacturer for cooling the set and its auxiliary equipment at an ambient temperature of 40 degrees C.

- J. Engine Accessories
 - 1. An electric starter capable of three complete cranking cycles without overheating before overcrank shutdown (75 seconds).
 - 2. Positive displacement, mechanical, full pressure, lubrication oil pump. Full flow lubrication oil filters with replaceable elements and dipstick oil level indicator.
 - 3. Engine mounted battery charging alternator, 40 ampere minimum, and solid-state voltage regulator.
- K. Mounting: Provide unit with suitable spring-type vibration isolators and mount on heavy duty steel base. The engine-generator set shall incorporate a battery tray with battery hold down clamps with the base rails.
- L. Provide unit with a lube oil heater and a coolant jacket heater, both wired to individual NEMA 12 junction boxes with identification nameplates.
- M. Start Time: Comply with NFPA 110, Type 10 (10 seconds) system requirements.
- N. Engine components, including but not limited to, the engine control unit, magnetic pickup, governor and actuators, alternator components, including but not limited to, the voltage regulator which shall be suitable for interfacing with a remote paralleling switchgear-mounted engine generator control package such as the Cummins 3.3 microprocessor-based engine-generator control.

2.3 GENERATOR

- A. Generator: Synchronous, four-pole, revolving field, air cooled AC generator. Marathon MagmaMAXdvr series or approved equal.
- B. Rating: 750 kW at 1,800 rpm and 0.80 power factor, 4.16Y/2.4kV.
- C. Insulation: Class F insulation class meeting the requirements of NEMA MG1. Provide vacuum-pressure impregnated non-hygroscopic materials.
- D. Alternator: 2/3 pitch factor and fully-linked amortisseur winding. Sub-transient reactance: 12% or less. Thermostatically controlled heater to maintain windings above the dew point.
- E. Temperature Rise: 105 degrees C.
- F. Enclosure: Open-drip proof, fully enclosed frame.
- G. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by nonlinear loads on the generator.
- H. Bearings
 - 1. Provide prepackaged regreasable bearings with a median expected life of 40,000 hours.
 - 2. Insulation. As necessary to prevent shaft-bearing frame currents.
- I. Hardware. Provide structural bolts, washers, nuts, pins, and similar items manufactured of high-strength steel. Use only hexagon-head bolts and hexagon nuts. Use corrosion-resistant materials or protect hardware from corrosion by hot-dip galvanizing, chrome plating or cadmium plating.
- J. Nameplates

1. Main Nameplate. Provide the generator with a stainless steel nameplate meeting the requirements of the National Electrical Code and NEMA MG 1 for synchronous generators. Include the following additional information on the main or an additional nameplate: insulation system classification, connection diagram, direction of rotation, electric phase rotation for NEMA standard direction of rotation and number of safe starts in succession, including duration of waiting period.
 2. Heater Nameplate. Voltage and wattage.
 3. Bearings Nameplate. Bearing identification and recommended lubricant.
 4. Attachment. Attach nameplates to the generator with stainless steel fastening pins or screws.
- K. Terminal Boxes
1. Description. Provide conduit terminal boxes and terminal housing cabinets for all wiring connections to generator.
 2. Material. Make small boxes of cast iron or cast bronze. Make large boxes of cabinet type construction of adequately braced 1/8-inch (11-gauge) sheet steel. Use machine screws to fasten all covers.
 3. Gaskets. Use durable gaskets resistant to heat, grease and moisture-laden air to seal all joints between boxes and covers or between boxes and machine enclosure.
 4. Auxiliary Leads. Terminate space heater and similar leads on 600-volt rated molded insulation terminal blocks with ring-tongue terminals under screws. Use only corrosion-resistant materials and brass screws. Effectively isolate terminal blocks for different functions by suitable air separation or individual boxes. Permanently identify all leads and terminals.
 5. Main Terminal Box. House main generator leads and surge protection equipment in an oversized cabinet with bolted panels. Provide appropriately rated copper bus and individually connect surge arresters and capacitors, and generator leads to bus with appropriate lugs. Allow ample space for stress cone termination of incoming feeder with conduit entrance from above. Include wireways that may be required for generator leads. Provide grounding lug in box for incoming grounding conductor.
- L. Space Heater
1. Type. Thermostatically controlled heater to maintain windings above the dew point. Electric resistance, silicon rubber clad or equivalent non-oxidizing exterior, with maximum surface temperature of 130 C (266 F).
 2. Wattage. As required to avoid condensation during shutdown, but not less than twice the value given in the Appendix of IEEE Standard 43, Paragraph A1.3 (twice the length in feet times the diameter in feet divided by 35).
 3. Voltage. 115 volts, single-phase, 60-hertz for 1500 watts or less; 208 volts, single-phase, 60-hertz for larger.
- M. Resistance Temperature Detectors (RTDs):
1. Stator:
 - a Quantity. Six, two per phase.
 - b Location. Embedded in the stator coils at 60-degree intervals and located to indicate the hottest area of the windings.
 2. Resistance. 100 ohms at 0C platinum RTD.
 3. Manufacturers:
 - a Cooper Power Systems (McGraw-Edison).
 - b Minco

- N. Acceptable manufacturers. Acceptable manufacturers are: Cummins Generator Technologies.
- O. Voltage Regulation:
 - 1. The automatic voltage regulator shall be temperature compensated solid-state design and include overvoltage and overexcitation protection functions. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. Overvoltage protection shall sense the AC generator output voltage, and in the event of regulator failure or loss of reference, shutdown regulator output on a sustained overvoltage of one (1) second duration. Overexcitation protection shall sense regulator output and shutdown regulator output if overloads exceed ten (10) seconds in duration. Both overvoltage and overexcitation protection shutdowns shall be latched, requiring the AC generator to be stopped for reset.
 - 2. The regulator shall include an under frequency roll-off torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58-59 Hz. The torque-matching characteristic shall include differential rate of frequency change compensation to use maximum available engine torque, and provide optimal transient load response. Regulators which use a fixed volts per hertz characteristic are not acceptable.

2.4 ACCESSORIES

- A. Engine Exhaust System: Use all stainless steel products. Provide exhaust pipe size from the engine to the silencer as recommended by the engine manufacturer, with flexible stainless steel bellow-type exhaust fittings for connections to the engine exhaust manifold.
- B. Exhaust Silencer: Super critical grade as recommended by the manufacturer with minimum 30-35 dBA attenuation. Material: stainless steel. Connections: ANSI standard flanges. Condensate drain with petcock. Required inlet/outlet orientation information will be provided prior to production of submittals.
- C. Provide GT Exhaust Systems Inc. or approved equal thermal wrap insulation around the silencer, silencer flanges, and flexible stainless steel bellows-type exhaust fittings.
- D. Starting/Control Batteries and Charger: Lead-calcium, starting batteries 24 volt DC, sized and supplied by the generator set manufacturer, with battery cables and connectors. Batteries shall mount on set using manufacturer's corrosion resistant skid-mounted, well-ventilated covered tray. Provide and install a 10-amp minimum, 24 VDC solid-state automatic battery charger, wall-mounting type, 120 VAC input, 1 phase, 60 Hz input.
- E. Remote Annunciators: Furnish two NFPA 110 Level 1 remote alarm annunciators: one for installation outside the engine-generator room and one for installation at the ground level freight elevator lobby. The remote annunciators shall provide all the indications and audible alarms required by NFPA 110, and in addition shall provide indications for high battery voltage, low battery voltage, normal battery voltage, battery charger malfunction, and low natural gas pressure. Alarm silence and lamp test switches shall be provided. One remote annunciator should have a SPDT dry contact suitable for use as a common alarm external interface to the building Johnson Controls Metasys system.
- F. Natural Gas Fuel Line Accessories: The generator set supplier shall furnish the following accessories for contractor installation in the engine fuel supply line within ten feet of the engine fuel intake: primary and secondary gas pressure reducing regulator (pounds to ounces) rated for the source gas pressure; 24 VDC, battery-operated starting solenoid

valve; fuel strainer; seamless metal-braided flexible fuel line; and AGA plug type manual shutoff valve.

- G. Remote emergency stop control device: Furnish one break-glass type emergency stop control device assembly for remote mounting. Engine-generator connection point: NEMA 12 junction box with identification nameplate.
- H. Lube oil, coolant, and other engine fluids: Provide initial fluids required for operation of the packaged engine-generator system.

2.5 FACTORY TESTS

- A. Before shipment, factory test the packaged engine-generator system manufactured specifically for this project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Measure insulation resistance.
 - 2. High potential testing.
 - 3. Measure winding resistance.
 - 4. Phase balance, current and voltage.
 - 5. Two hour full load run at rated power factor.
 - 6. Maximum power.
 - 7. Voltage regulation.
 - 8. Transient and steady state governing.
 - 9. Single-step load pick-up.
 - 10. Start time.
 - 11. Safety pre-alarms, alarms, and shutdowns.

PART 3 - EXECUTION

3.1 FIELD ASSEMBLY AND SET-UP

- A. The generator will be located in a room in the Penthouse that previously housed a generator. Access to this room is available only via an opening from the roof down to the room. This opening will end up being the generator exhaust shaft. The size of the opening does not allow for the generator to be installed in one piece. The generator shall be disassembled to allow it to be installed in several pieces consisting of the radiator, alternator, engine and skid. The skid may have to be constructed in separate sections due to its length. Refer to plans for dimensions of roof opening and provide genset components that will fit in the opening.
- B. Make cooling system connections and adjustments.
- C. Make fuel system connection and adjustments.
- D. Install engine-generator fluids, and perform other engine-generator set-up work required for testing and start-up.

3.2 START-UP

- A. Provide manufacturer-recommended start-up service.

3.3 CLOSE-OUT, OPERATIONS AND MAINTENANCE INSTRUCTIONS

- A. Provide four hours training by a service engineer to the University's operations and maintenance personnel to adjust, operate, and maintain the packaged engine-generator system.
- B. Provide Operations and Maintenance Manuals. Include start-up service reports.

3.4 FIELD TESTS

- A. General.
 - 1. Perform field tests at the site after installation is complete and in the presence of the Owner's Representative. Notify Owner's Representative 15 working days before each test.
 - 2. Manufacturer's Representative. Have the engine generator manufacturer furnish a representative to operate the unit during the field tests, to check all details of the installation, and to instruct the operators. Include the services of the representative at no additional cost to the Owner.
 - 3. Preparation for Testing. Have the engine generator system completed and ready for operation at the time field tests are to be run. Provide all necessary lube oil, coolant, and other fluids, and install new, unused oil and air filter elements.
 - 4. Instruments. Provide all instruments necessary to conduct the tests.
 - 5. Design, Specification, and NFPA 110 Parameters. For each recorded parameter, provide a written tabulation of the manufacturer's published range of permissible operating values and design parameters. Tabulation shall also include parameters specified by this section, and parameters required in accordance with field testing per NFPA 110.
- B. Installation Test. Perform on-site installation test in accordance with NFPA 110 in the presence of the Owner's Representative.
- C. Crank Cycle Test. Perform crank cycle test in accordance with NFPA 110 in the presence of the Owner's Representative.
- D. 6-Hour Test.
 - 1. Complete a 6-hour, load test using available building loads as a condition for final acceptance. Use different sequenced start-ups of various loads as directed by the Owner's Representative.
 - 2. Read and record all gauges and meters before starting the test, then every 5 minutes during the first 15 minutes, then every 15 minutes during the next 2 hours, and then every half hour during remainder of the 6-hour period.
 - 3. Remove load and run engine generator at no load for 15 minutes; then shut unit down and immediately make one last recording of all gauge and meter indications.
 - 4. Have recordings field witnessed during test by the Owner.
 - 5. Deliver copies of witnessed recordings to the Engineer and the Owner's Representative within one week of the test. Deliver two copies to the Engineer and six copies to the Owner's Representative.
- E. After final testing, verify that coolant and lubricant are at satisfactory levels, and fill as required.

END OF SECTION

SECTION 26 76 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles
- C. Plates.

1.3 RELATED SECTIONS

- A. Section 26 05 19 – Conduits, Raceway, Boxes.
- B. Section 26 05 26 – Grounding.

1.4 REFERENCES

- A. NEMA WD 1 – General-Purpose Wiring Devices.
- B. NEMA WD 2 – Semiconductor Dimmers for Incandescent Lamps.
- C. NEMA WD 5 – Specific-Purpose Wiring Devices.
- D. Americans with Disabilities Act (ADA).
- E. ANSI/UL 20 – General Use Snap Switches.
- F. ANSI/UL 498 – Attachment Plugs and Receptacles.
- G. ANSI/UL 943 – Ground Fault Circuit Interrupters.

1.5 SUBMITTALS

- A. Refer to Division 01. Submit manufacturer's product data for wiring devices and floor boxes.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Arrow-Hart.
 - 3. Leviton.
 - 4. Pass & Seymour.

- B. Switches:
 - 1. Single Pole: 20 ampere, Hubbell 1221.
 - 2. Three Way: 20 ampere, Hubbell 1223.
 - 3. Four Way: 20 ampere, Hubbell 1224.
 - 4. Two Pole: 20 ampere, Hubbell 1222.

- C. Provide red toggle switches where served by emergency circuits.

2.2 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Arrow-Hart.
 - 3. Leviton.
 - 4. Pass & Seymour.

- B. Receptacles:
 - 1. Duplex: 20A, 125V, 2P, 3W, Grounding, NEMA Configuration 5-20R, Hubbell 5262.
 - 2. Single: 20A, 125/250V, 3P, 4W Grounding, NEMA Configuration 14-20R, Hubbell 8410.
 - 3. Single: 30A, 125/250V, 3P, 4W Grounding, NEMA Configuration 14-30R, Hubbell 9430A.
 - 4. Single: 50A, 125/250V, 3P, 4W Grounding, NEMA Configuration 14-50R, Hubbell 9450A.
 - 5. Ground Fault Interrupting: 20A, 125V, 2P, 3W, Grounding, Hubbell GF5262.

- C. Provide red receptacles where served by emergency circuits.

2.3 PLATES

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Arrow-Hart.
 - 3. Leviton.
 - 4. Pass & Seymour.

- B. General: Furnish plates suitable for the device.

- C. Finished Areas: Type 302/304 stainless steel 18% chrome, 8% nickel as follows:
 - 1. Switch Plates: Hubbell Type S1.
 - 2. Duplex Receptacles: Hubbell Type S8.

3. GFCI: Hubbell Type S26.
4. Blank: Hubbell Type S14.
5. Other: Hubbell Type S as appropriate for device.
6. Use ganged plates for adjacent devices.

D. Emergency Circuits: Furnish red device plates.

2.4 WEATHERPROOF COVERS

A. Provide weatherproof while in use covers per NEC.

B. Manufacturers:

1. Hubbell.
2. Arrow-Hart.
3. Leviton.
4. Pass & Seymour.

C. Description: Cast aluminum.

1. Vertical Duplex: Hubbell WP8M.
2. Vertical GFCI: Hubbell WP26M.
3. Horizontal Duplex: Hubbell WP8MH.
4. Horizontal GFCI: Hubbell WP26MH.

2.5 EXPOSED WORK COVERS

A. Manufacturers:

1. Steel City.
2. Crouse-Hinds.
3. Appleton.

B. Description: Stamped steel with edges flush against sides of box, suitable for indicated device, Steel City Type RS.

2.6 SPECIAL PURPOSE OUTLETS

A. As noted on the plans.

2.7 WIRING DEVICES IN SPECIAL WALLS

A. Coordinate color of devices in paneled walls, walls covered with carpet or walls covered with vinyl with Owner's Representative.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions under provisions of Division 01.
- B. Verify outlet boxes are installed at proper height.
- C. Verify wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify floor boxes are adjusted properly.

- E. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- E. Do not share neutral conductor on load side of dimmers.
- F. Install receptacles with grounding pole on top.
- G. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor. Delete bonding jumper for isolated ground receptacles.
- H. Connect wiring devices by wrapping conductor around screw terminal.
- I. Use jumbo size plates for outlets installed in masonry walls.
- J. Install no more than six receptacles on a single circuit. Do not combine corridor receptacles with circuits serving other rooms.
- K. Identify receptacles in accordance with section 26 05 00.

3.4 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

END OF SECTION

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10/3/2016

Shah Smith & Associates, F-2113

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the common work results requirements for Division 22, Plumbing. Applicable provisions of this Section apply to all Sections of Division 22.

1.2 GENERAL

- A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements and provide coordination drawings.
- B. Prior to starting work, Contractor shall provide 1/4 inch scale coordination drawings for all areas of the buildings for approval by Architect/Engineer.
 - 1. Drawings shall show all equipment, piping, ductwork, cable trays, fire protection systems, coil pull spaces, chilled water, heating water, and condensate piping and trap, electrical conduit, electrical control panels, etc. installed to verify space allocation and coordination of trades.
 - 2. Provide plan and elevation views detailing installation.
 - 3. Do not proceed with construction of plumbing systems until Drawings have been approved by Architect, Engineer, and Owner.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 CODE REQUIREMENTS AND PERMITS

- A. Perform work in accordance with applicable statutes, guidelines, ordinances, codes, and regulations of governmental authorities and owners having jurisdiction.

- B. Resolve code violations discovered in contract documents with Engineer prior to award of Contract. After award of Contract, make correction or addition necessary for compliance with applicable codes at no additional cost to Owner.

1.5 SUBMITTALS

- A. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.
- B. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data at one time for review for items of equipment and for principal materials proposed for installation. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.
- C. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.
- D. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.

1.6 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish five copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:
 - 1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
 - a. Recommended procedures and frequencies for preventive maintenance, inspection, adjustment, lubrication, cleaning, etc.
 - b. Special tools and equipment required for testing and maintenance.
 - c. Parts lists reflecting the true manufacturer's name, part number, and nomenclature.
 - d. Recommended spares by part number and nomenclature and spare stocking levels.
 - e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
 - f. Troubleshooting, checkout, repair, and replacement procurement procedures.
 - g. Operating instructions including start-up and shutdown procedures.

- h. Safety considerations including load limits, speed, temperature, and pressure.
- B. Provide O&M manuals for all plumbing equipment. Coordinate O&M manuals with Division 01.
- C. Upon completion of work, and at time designated by the Architect/Engineer, provide services of a competent representative of the Contractor for a period of at least 40 hours to instruct the Owner's Representative in the operation and maintenance of the entire system.

1.7 PROJECT RECORD DOCUMENTS

- A. Preparation:
 - 1. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.
 - 2. Mark the drawings with a colored pencil.
 - 3. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed
 - 4. Include flow-line elevation of sewer lines.
 - 5. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.
 - 6. Coordinate requirements for Project Record Documents with Division 01.
- B. Deliver: At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these. Delivery of as-built prints and reproducibles is a condition of final acceptance.

1.8 GUARANTEE

- A. Guarantee work for 1 year from the date of final acceptance of the project, and during that period make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship. Coordinate requirements for Warranty with Division 01.

1.9 SERVICE

- A. Perform service work required during the guarantee period including lubrication of bearings. Perform service monthly, and provide the Owner with a written report. Cleaning of air filters and pipe strainers is not included.

1.10 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions (except where specified otherwise in individual sections), revisions, amendments or supplements in effect on date bids are received.

1. Requirements in reference specifications and standards are minimum for all equipment, material and work.
2. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.

1.11 CUTTING AND PATCHING

- A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.
- B. Methods of Cutting:
 1. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
 2. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer.
 3. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.
- C. Restoration:
 1. All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.
- D. Masonry:
 1. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
 2. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation.
 3. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.
- E. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

1.12 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacturer where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are listed in individual Sections of Division 22. Manufacturer's names and catalog numbers specified under Sections of Division 22 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturer's list will be accepted upon approval.

B. Substitutions:

1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
3. The Architect/Engineer will not give approval to material salesmen or subcontractors and only in writing to the successful Contractor after the project has been awarded.
4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest.
7. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.
8. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural, or architectural, which may result from the substitution.
9. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

2.3 PIPE STRAINERS

- A. Immediately prior to final acceptance of project, inspect, clean and service piping system strainers.

- B. Turn over to Owner additional sets of spare parts as specified.

2.4 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

2.5 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.6 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8" Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, 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 or BAg1, unless otherwise indicated.
- E. Welding Filler Metals: Comply with AWS D10.12.
- F. Solvent Cements for Joining Plastic Piping:
 1. ABS Piping: ASTM D 2235.
 2. CPVC Piping: ASTM F 493.
 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 4. PVC to ABS Piping Transition: ASTM D 3138.

2.7 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: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180°F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225°F.

2.8 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 SLEEVES

- A. Through Floors: Galvanized schedule 40 steel pipe sleeve with water ring, as detailed.
- B. Through Walls in Crawl Space: Galvanized schedule 40 steel pipe sleeve with water ring, as detailed.
- C. Sleeves Through Interior Walls: 22 gauge galvanized steel snap lock. No screws through vapor barrier.

2.10 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.

2.11 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, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. 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.

- O. 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 annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. 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.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section, Penetration Firestopping, for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections for roughing-in requirements.
- S. Provide fire rated type access panels in fire rated walls where indicated in drawings. Access panel to match or exceed to wall rating.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections 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 end. 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, 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. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 OBSTRUCTIONS

- A. Drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.
- C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.6 OPENINGS

- A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.7 PROTECTION

- A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.
- B. Cover all equipment stored exposed to elements with waterproof tarps. Provide adequate ventilation. At work completion, all work must be clean and in like new condition.
- C. Storage of all mechanical equipment and piping materials shall be in strict accordance with manufacturers written installation instructions.
- D. Provide factory installed pipe caps for all pipes to be installed on the project.

3.8 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section, Cast-in-Place Concrete.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section, Metal Fabrications, for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.11 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.12 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

- A. All equipment utilized will be checked out by a factory representative, serviced, lubricated, checked for rotation, pressure, amp draw and vibration isolation, adjusted and

certified. Record of this service must be provided monthly to the Owner. Submit appropriate reports to the University prior to submitting a written request for service.

- B. All equipment operated shall be serviced on a regular basis by the Contractor.
- C. Prior to final inspection, clean all equipment inside and out to a like new condition, remove temporary filters, install new permanent filters in preparation for final inspection by Owner.
- D. All warranties will be commenced at the time of final acceptance.

3.13 OPERATING TESTS

- A. After all plumbing systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner's Representative.
- B. Prove operations of control systems and all safeties, and alarms. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual Sections.
- C. Functional Performance Testing is part of the Commissioning Process. Functional performance testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 019113, General Commissioning, for functional performance testing and commissioning requirements.

3.14 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish five copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:
 - 1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
 - 2. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
 - 3. Special tools and equipment required for testing and maintenance.
 - 4. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
 - 5. Recommended spares by part number and nomenclature and spare stocking levels.
 - 6. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
 - 7. Troubleshooting, checkout, repair and replacement procurement procedures.
 - 8. Operating instructions including start up and shutdown procedures.
 - 9. Safety considerations including load limits, speed, temperature and pressure.
 - 10. Provide O&M manuals for all plumbing equipment. Coordinate requirements for O&M Manuals with Division 01.

3.15 OPERATING INSTRUCTIONS

- A. Upon completion of work, and at time designated by the Owner's Representative, provide services of a competent representative of the Contractor for a period of at least 40 hours to instruct the Owner's Representative in the operation and maintenance of the entire system. The training sessions will be video taped for instructing future technicians.
- B. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 019113, General Commissioning, for contractor training requirements.
- C. Coordinate requirements for training with Division 01.

END OF SECTION

SECTION 22 05 26

PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for pipe and pipe fittings for all piping systems. This Section applies to all Plumbing Sections of Division 22 which employ pipe and pipe fittings. Fabricate and erect all piping in accordance with ASME/ANSI B31.9 except as otherwise indicated.

1.2 RELATED SECTIONS

- A. Division 07 – Thermal and moisture protection for firestopping requirements.
- B. Division 09 – Finishes for painting requirements.
- C. Section 22 05 00 – Common Work Results for Plumbing
- D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- E. Section 22 11 16 - Domestic Water Piping.
- F. Section 22 11 19 - Domestic Water Piping Specialties.
- G. Section 22 13 19 – Sanitary Waste and Vent Piping.
- H. Section 22 14 23.13 - Roof Drainage Piping Systems.

1.3 SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 paragraphs where titles below introduce lists or manufacturers, the following requirements apply to product selection:
 - 1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the manufacturer specified.

2.2 PIPE AND FITTINGS

- A. The particular type of pipe and fittings for each system is specified in the Section for that system. All piping and fittings shall be of U.S. Manufacturer. All pipe shall be shipped capped. Shipped and store on job site with ends capped from the factory.

2.3 JOINTS

- A. Screwed: Make screwed joints using machine-cut ANSI taper pipe threads. Apply a suitable joint compound, such as Teflon tape, to the male threads only. Ream the pipe to full inside diameter after cutting. All-thread nipples are not permitted.
- B. Dissimilar Metals: Make joints between copper and steel pipe and equipment along with steel pipe and ductile iron pipe using insulating unions such as Crane Company No. 1259; EPCO as manufactured by EPCO Sales, Inc.; or an approved equal.
- C. Solder Joints:
1. Prior to making joints, cut pipe square and ream to full diameter. Clean exterior of pipe and socket. Apply a thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
 2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.
 3. Utilize lead free solder. Use silver brazing alloy or Sil-Fos on refrigerant piping and on underground piping.
- D. Welded Joints:
1. Make welded joints as recommended by the standards of the American Welding Society.
 2. Ensure complete penetration of deposited metal with base metal.
 3. Provide filler metal suitable for use with base metal.
 4. Keep inside of fittings free from globules of weld metal.
 5. Do not use mitered joints.
 6. Use standard weld elbow fittings for changes of direction or cut a standard elbow for odd angles.
- E. Flanged Joints:
1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.
 2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.
 3. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Red rubber gaskets are not acceptable. Garlock gaskets or EPDM shall be used. Apply non-stick clean surface lubricant coating to both sides of gaskets.
 4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use Coreten or galvanized steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets. Use anti-seize compound on all bolts above and below grade. Bolt threads not to protrude more than 2 threads past nut.

5. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105, Grade II or ASTM A 108, Grade II. Use welding neck type flanges at all fittings and on all pipe.
 6. Flanges for ductile iron pipe are specified in Sections using that pipe.
 7. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.
- F. No Hub: Install according to manufacturer's recommendations, using recommended tools.
- G. Bell and Spigot: Use neoprene compression gaskets for sanitary and storm.
- H. Push-on Joints (Ductile Iron Pipe): Restrained joints and gaskets for ductile iron pipe are specified in Sections using that pipe.

2.4 UNIONS

- A. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

2.5 BRANCH CONNECTIONS

- A. For Pipe 2 inches and smaller, use threaded fittings for steel pipe. For threaded piping, use straight size of reducing tee.
- B. For 2-1/2 Inches through 14 Inches: For welded piping, when branch size is the same as and one size smaller than header size, use welding tee. Use Weld-O-Let when branch is two or more sizes smaller than header. For threaded branch connections, use thread-o-let welded to header.
- C. All changes in direction, branches, offsets etc., shall be made with standard pipe fittings. Holes in the main for branches shall be made with a hole cutting machine and a standard "Weld-O-Let" or "Thread-O-Let" fitting used. Burning holes in the system piping will cause that section of the piping to be cut out and replaced at the Contractor's expense

2.6 GASKETS

- A. Provide gaskets between flanges of all flanged joints. Inside diameter of gaskets shall conform to nominal pipe size. Gaskets shall be ring type between raised face flanges and full face between flat face flanges with punched bolt holes and pipe opening.
- B. Gaskets shall be cut from 1/8 inch thick non-metallic, non-asbestos gasket material suitable for operating temperatures from -150°F to +750°F. Garlock or equal. For pipe smaller than 6 inches, use 1/16-inch-thick gasket.

2.7 FLOOR AND CEILING PLATES

- A. Provide chrome-plated floor and ceiling plates around pipes exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Size plates to fit pipe or insulation and securely lock in place.

PART 3 - EXECUTION

3.1 PIPE FABRICATION AND INSTALLATION

- A. Make piping layout and installation in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance for other work.
- B. Give particular attention to piping in the vicinity of equipment. Preserve the maximum access to various equipment parts for maintenance. Install piping plumb and parallel with building walls.
- C. Do not cut or weaken any structural member.
- D. Cut all pipes accurately to measurement determined at the site. After cutting pipe, ream it to remove burrs.
- E. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make all changes in direction. Field bending and mitering are prohibited. Make all connections to equipment using flanged joints or unions. Make reducing connections with reducing fittings only.
- F. All water piping installed above ground or below ground and in trenches, must be installed by a licensed Plumbing Contractor at building rates. The wage rates for building trades apply only to the extent of work required to be installed by licensed Plumbing Contractors.

3.2 WELDING

- A. Weld and fabricate piping in accordance with ANSI Standard B31.9, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
- B. 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.
- C. 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.
- D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
- E. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.3 OFFSETS AND FITTINGS

- A. Because of the small scale of Drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.

- B. Install all piping close to walls, ceilings, and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.

3.4 PIPE SLEEVES

- A. Fit with sleeves all pipes passing through gyp board, masonry, and concrete construction, refer to specification section 22 05 00 and the following:
 - 1. Provide 22 gauge wall sleeves for pipes passing through gyp board walls.
 - 2. Fabricate floor sleeves of schedule 40 weight galvanized steel pipe and masonry wall sleeves of 40 gauge galvanized steel.
 - 3. Size sleeve for minimum clearance between pipe or insulation and sleeve.
 - 4. All sleeves in wet lab areas to have a welded waterstop.
 - 5. All sleeves shall be hot dipped galvanized after fabrication.
- B. Extend each sleeve through the floor or wall. Cut the sleeve flush with each surface, except that in exposed locations, extend floor sleeves 2 inches above finished floor line.
- C. Seal all sleeves water and airtight. Seal annular space between pipes and sleeves with compound with flame and smoke spread rating of minimum 25/50 in accordance with ASTM E 84 test.
- D. Sleeves below grades in outside walls are detailed on drawings. Except as shown otherwise, provide Thunderline Link-Seal or approved equivalent with stainless steel nuts and bolts, with cast iron pressure plate.

3.5 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 all equipment, and at other locations as indicated and required for isolation of piping or equipment.

3.6 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 a 2 inch drain for 2-inch pipes and larger. Install a line size drain valve for pipes smaller than 2 inches. Provide hose adapter and cap on all drain lines.
- B. Provide automatic vents with isolation valves or manual vents at locations as indicated on drawings and all high points in piping systems.

3.7 CLEANING OF PIPING SYSTEMS

- A. Cleaning of piping system must be performed by an independent agency specializing in this type of work:
 - 1. The agency must have a minimum of 5 years experience with at least three projects of similar size.
 - 2. Submit project names for review.
- B. Minimum velocity of 10 feet per second must be maintained in the pipes during flushing period:
 - 1. Do not use building pumps for circulating water.

2. Provide temporary pumps as required to achieve minimum velocities.
 3. Remove flow meters from building piping during flushing operation.
 4. Provide means (instrumentation) during flushing period to prove to the Owner that the minimum velocities are maintained in the pipes.
- C. Submit a detailed plan for the Engineer's and Owner's review and approval describing in full detail the individual steps associated with this process before any piping is installed:
1. Plan must include a drawing indicating GPM's required to provide minimum velocity required in the piping, phasing of systems being cleaned, locations of drains or other temporary connections required for cleaning system, and cutsheet of temporary pump proposed.
- D. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Provide temporary connections and valves as required for cleaning, purging and circulating.
- E. Install temporary strainers in front of pumps, tanks, water still, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blowoff valve.
- F. Domestic Water Piping:
1. All potable water piping and tanks shall, after successful pressure testing, be thoroughly flushed with clear water and then sterilized.
 2. Sterilization shall be with either liquid chlorine or chlorine gas of adequate volume to give a concentration of 50 ppm based upon the volume of the system being treated.
 3. The solution will be allowed to stand for a period of 24 hours.
 4. A minimum residual chlorine level of 5 ppm shall remain in each system for a minimum of 24 hours.
 5. After sterilization, all piping shall be thoroughly flushed.
 6. The above are minimum requirements and all sterilization procedures shall be in strict accordance with all local codes and authorities having jurisdiction.
 7. Under no circumstances shall the Contractor permit the use of any portion of the domestic water system until it has been properly sterilized and certified by the authorities having jurisdiction.
- G. Special requirements, if any, are specified in the Sections for each type of piping.
- H. After systems have been flushed, cleaned and sterilized; as required by specifications, provide written certification from the cleaning contractor that the systems are clean and ready for use.

3.8 LEAK TESTS

- A. All piping systems shall demonstrate leak tightness. This requirement shall be met by a water hydrostatic leak test or a pneumatic leak test, whichever is called for under specific piping Sections.
- B. Piping Systems:
1. Test Preparation: Expansion joints shall be provided with temporary restraint, for the additional pressure load under test or shall be isolated from the test.

- Equipment and valves which are not rated for the pressure test shall be either disconnected from the piping or isolated by a blind flange or similar means.
2. Test Pressure” The water hydrostatic test pressure shall be 1.5 times the design pressure. The pressure test shall be maintained for sufficient time to inspect all joints, with a minimum time of four hours.
 3. Special requirements, if any, for each system are specified in the Section for that system.

3.9 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

- A. Provide service connections to items of equipment furnished by others:
 1. Detailed shop drawings of equipment will be furnished indicating the exact number and location of rough-in points.
 2. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions.
 3. Making adjustments to field conditions is considered a part of the work required.
- B. Roughing-In:
 1. When roughing-in, extend service piping to various items of equipment.
 2. Temporarily terminate at proper points as indicated on detailed equipment shop drawings or as directed.
 3. Do not use contract drawings accompanying these specifications for rough-in locations but only for pipe sizing and general routing.
- C. Stop Valves:
 1. Provide stop valves for each service at rough-in locations, except for drains.
 2. Stop valve locations are subject to approval, and in all cases must be accessible from the same room in which the furniture or equipment is located.

3.10 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

- A. Refer to Specification 22 05 00, Common Work Results for Plumbing, for requirements that must be completed prior to requesting the Owner to provide chilled water or hot water from the building distribution system.

3.11 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.
- B. Division 03 Section - Concrete, for concrete requirements.
- C. Division 05 Section - Metal Fabrications, for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- D. Division 09 Section - Painting, for painting requirements.
- E. Section 22 05 00 – Common Work Results for Plumbing

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Equipment supports.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Anvil
- B. Cooper B-Line
- C. Erico
- D. Unistrut
- E. Nibco
- F. PHP

2.2 CLEVIS TYPE HANGERS

- A. Adjustable steel clevis hangers (MSS1 Type 1)

2.3 METAL FRAMING SYSTEMS

- A. Provide fabricated cadmium plated steel framing members and appurtenances for interior pipe supports as shown:
 - 1. Mult-A-Frame, Unistrut, Cooper B-Line and Power-Strut pipe support systems also are acceptable.
 - 2. Support piping from precast and pan joist structure as detailed on Drawings.
 - 3. Powder actuated anchors are not permitted.
 - 4. Sleeves penetrating beams must be submitted through Structural Engineer. Refer to plumbing drawings for locations.
- B. Framing channel type support systems shall be 12-gauge cold-formed carbon steel conforming to ASTM A570 GR33:
 - 1. Fittings for framing channel system shall be punch pressed electro-galvanized carbon steel conforming to ASTM A575, A576, A635 and A36.
 - 2. Bolts and nuts shall have unified coarse screw threads with standard 1/2 inch nuts, conforming to ASTM A576 GR1015 AND ASTM A307.
 - 3. Components shall have a pre-galvanized zinc coating conforming to ASTM A525, except where indicated.

2.4 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier with vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Concrete: Provide 3,000 psi concrete. Reinforce slab with No. 4 rebar on 12 inch center each way centered in slab unless indicated otherwise on Drawings.
- C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Metallic coatings for piping and equipment that will not have field-applied finish. All hangers and supports shall be cadmium plated. Hangers and supports in crawl space shall be hot dipped galvanized
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120°F to 450°F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23): For structural shapes.
 - 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 - 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified herein for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- N. Do not support piping from other piping.
- O. Where uninsulated (bare) copper pipe is supported by clevis hangers and riser clamps. The hangers shall be plastic coated or copper.
- P. Where uninsulated (bare) copper pipe is clamped to a dissimilar metal, such as steel, the copper pipe shall be installed with a felt isolator or Vibra Cushion No. B1999 manufactured by B-Line, Erico "Caddy" Cushion Clamp, or approved equal.

- Q. Isolation tape wrap is only acceptable where a clamp or support does not occur and where pipe is in connect with a building element.
- R. Place hangers not more than 6 feet apart on 1/2 inch and 3/4 inch pipes, or 10 feet apart on larger pipes unless noted otherwise on plans. Place hangers not more than 6 feet apart for all sizes of polyvinyl chloride pipe. Refer to manufacturer's recommendations for supporting polypropylene piping. For copper piping, place hangers as follows:
 - 1. For sizes up to 1 inch – maximum 5 feet - 0 inches O.C.
 - 2. For sizes 1-1/4 inch to 1-1/2 inch – maximum 7 feet - 0 inches O.C.
 - 3. For sizes 2 inches to 3 inches and larger – maximum 9 feet - 0 inches O.C.
- S. Support vertical risers as detailed on drawings at every floor:
 - 1. All water piping 2 inches or smaller shall be supported with galvanized steel strap pipe clamps of approved designed and sizes, properly supported at every floor.
 - 2. Support piping assemblies in chases adequately enough to be rigid and self-supporting before the chase is closed.
 - 3. Provide adequate structural support for piping penetrating chase walls to fixtures.
- T. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified in the appropriate insulation Section.
- U. Perforated bar hangers, straps, wires or chains are not permitted.
- V. For cast iron piping, refer to specification section 22 13 16.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with 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. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Warning signs and labels.
 - 2. Pipe labels.
 - 3. Stencils.
 - 4. Valve tags.
 - 5. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufactures: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services, Inc.

3. Seton Identification Products.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Background to contrast with letter color.
- D. Maximum Temperature: Able to withstand temperatures up to 160 °F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include Identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inch high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Brass.
 - 2. Paint: Standardized colors for the entire natural gas piping system painted per Division 09 painting specification. Paint material is based on colors and model numbers manufactured by Glidden unless otherwise indicated. Entire natural

gas piping system shall be primed and painted where outdoors. Subject to compliance with requirements, provided named color or comparable product as approved. Use the following colors for banding of all piping and conduit:

SYSTEM	COLOR
Natural Gas	Yellow, comparable to ICI/Glidden #9400

3. Standardized Sizes: Tags shall be at least 1-1/2 inches in diameter, with depressed block characters 1/4 inch high. Titles shall be lettered on bands. Uppercase letters and Arabic numerals shall be used. Where pipes or conduits are too small or not readily accessible for such application securely fasten a brass identification tag at appropriate locations. Identification of the material contained in piping and conduits in accordance with the table below:

BAND AND LETTER SIZE ALL DIMENSIONS IN INCHES		
Outside Diameter of Pipe Covering	Width of Color Band	Size of Letters and Numerals
1/2 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/4 to 3-1/4	10	1
3-1/2 to 6	12	1-1/4

4. Pipe Identification: Identify pipe at wall penetrations, machine or tank connections, and at not over 50 foot intervals. Marker identification shall be legible and should be visible from the floor. Mark each pipe circuit with stencil. Stencil shall include flow arrow and identification marks as follows:

Non-Potable Makeup Water	Non-Potable-W
Natural Gas	Nat-Gas

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4 inch letters for piping system abbreviation and 1/2 inch numbers.
1. Tag Material: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2 X 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: 3 X 5-1/4 inches minimum.

2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Equipment to be identified with plastic nameplates includes but is not limited to water heaters, filters, plumbing equipment, tanks, and water treatment devices.
- B. Identify small devices, such as in-line pumps with metal tags.
- C. Identify valves with tags.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 painting sections
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
 1. Identification Paint: Use for contrasting background.
 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment. For natural gas provide labels maximum every 15 feet - 0 inches.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-

watering hose connections; and similar roughing-in connections of end-use fixtures and units.

- B. List tagged valves in a valve schedule in aluminum frame with clear plastic shield. Install at location as directed by Owner's Representative.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 22 11 17

GAS PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section provides requirements for furnishing and installing gas piping inside and outside of building, including the supply line from the gas meter, service lines to gas equipment and appliances, termination of the service line with a valve, and final connection to equipment and appliances. Also included shall be the gas vent piping. Contractor is responsible for all fees required by the natural gas utility company to furnish the complex gas meter assembly with main pressure regulator and installation of natural gas piping system extending to the complex from utility company gas main located adjacent to property as indicated on drawings. Refer to civil drawings for general routing to the complex. All work shall be compliant with NFPA 54 and UPC Chapter 12.

1.2 RELATED WORK

- A. Section 22 05 00, Painting.
- B. Section 22 05 00, Common Work Results for Plumbing.
- C. Section 22 05 26, Pipe and Pipe Fittings.
- D. Section 22 05 53, Identification for Plumbing Piping and Equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. 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.
- C. Delegated-Design Submittal: For 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.
 - 1. Detail fabrication and assembly of anchors and seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication and assembly of pipe anchors, hangers, supports for multiple pipes, and attachments of the same to building structure.
- D. Brazing certificates.
- E. Welding certificates.

- F. Field quality-control reports.
- G. Operation and maintenance data.
- H. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

- A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- D. 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.
- E. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.
- F. Comply with requirements of the EPA and of state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks and piping.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Ball Valves: Subject to compliance with requirements, provide products by one of the following:
 - 1. Watts.
 - 2. Stockham.
 - 3. Nibco.
- B. Lubricated Plug Valves: Subject to compliance with requirements, provide products by one of the following:
 - 1. Fisher.
 - 2. Nordstrom.
 - 3. Milliken.

2.2 PIPE AND FITTINGS

- A. Piping:
 - 1. Above Ground: Pipe and fittings downstream of kitchen equipment automatic shut-off valve shall be Schedule 40, ASTM A 53, black steel with black 150-pound malleable iron screwed fittings, conforming to ANSI B16.3. Pipe and Fittings for 2 inch and smaller in all locations, upstream of equipment and

automatic shutoff valves shall be schedule 40, ASTM A 53, black steel with socket weld carbon steel fittings conforming to ANSI B16.11. Pipe larger than 2 inches in all locations: Provide Schedule 40, ASTM A53, black steel pipe with long radius butt weld fittings. Valves and fittings at equipment connections shall be threaded. Outdoor aboveground pipe and fittings 2 inch and less shall have threaded joints, and pipe and fittings over 2 inch shall be butt welded.

- B. Unions: Use 150-pound standard (300-pound water, oil or gas) malleable iron, ground joint unions, with bronze seat. Provide flange joints for pipe 3 inches and larger in diameter.
- C. Flanges: Furnish Class 125 ANSI cast iron flanges.
- D. At equipment connections and where indicated on floor plans, the flexible connectors shall be corrugated stainless steel, ASTM A240, with U/V resistant polyethylene jacket, ASTM E84 compliant index for flame and smoke, manufactured by Gastite.

2.3 VALVES

- A. Ball Valves: For valves at equipment, provide two piece, 600 psi WOG, cast brass body, replaceable reinforced Teflon seats, full port, blowout-proof stem, chrome-plated brass ball, threaded ends, carbon steel handle, quarter turn, MSS-SP-110 compliant, UL listed and CSA approved for natural gas service stamped directly on valve body (125G), manufactured by Nibco Model T-585-70-UL, or approved other.
- B. Plug Valves: Lubricated type, suitable for bi-directional dead end service, bubble tight shut-off, Port area at least 80% of the pipe area, self-cleaning plug sealing surfaces, cast iron ASTM A126 Class B body, threaded connection for sizes through 2 inch downstream of emergency shut-off valves, and flanged for all sizes upstream of emergency shut-off valves. Bolted bonnet, permanently lubricated with baked TFE or thermosetting epoxy boded to plug, ball checks, cast iron shaft with wrench operator for sizes smaller than 4 inch, position indicator, memory stop, specifically designed for natural gas service, CGA approved, GSA approval stamped on valve as fuel gas rated, manufactured by Nordstrom Figure 142, 143 or Walworth Figure 2720 and 2721.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The serving utility company (Centerpoint Energy) will provide connection to an existing gas main and service to the Complex Natural Gas meter assembly. Give proper notice and pay all fees and other costs for complete gas service.

3.2 INSTALLATION

- A. Installation Standards: The installation of the entire natural gas system shall be in accordance with NFPA 54 and UPC Chapter 12.
- B. Drip Legs: Install a capped drip leg 6 inches long at the base of each vertical riser and at each equipment connection.

- C. Where natural gas piping is installed vertically, not grouped with other piping, secure to wall with hanger similar to B-Line Figure BL1400. Hanger shall be primed and painted to match wall. Hanger shall be on 4'-0" O.C. spacing.
- D. Sleeves:
 - 1. Encase gas piping running in or through solid partitions and in spaces within the building in which gas might collect or from which gas might be introduced into supply or return air systems.
 - 2. For encasement or sleeving, use Schedule 10, black steel pipe and fittings conforming to ASTM A 120, with welded joints.
 - 3. Sleeve piping and fittings must be two pipe sizes, but not less than 1 inch larger than encased gas piping.
 - 4. Vent sleeve to outside, or to nearest ventilated space discharging to outside.
 - 5. Sleeving is not required for gas piping located above ceilings.
- E. Connections:
 - 1. Make threaded joints with square, clean, full cut, standard taper pipe threads.
 - 2. Ream after cutting and threading. Use heavy duty teflon sealing compound or teflon tape as threading seal.
 - 3. Sealing compound shall be non-toxic, non-drying, anti-seize, UL classified, and AGA approved.
- F. All aboveground natural gas piping shall be primed and painted.

3.3 CLEANING AND PURGING

- A. Follow guidelines set forth in NFPA 54 and UPC Chapter 12, and as specified.
- B. Pipe, tubing, fittings, valves and equipment shall be visibly clean of foreign material before being installed into the system. Pipe shall be cleaned by hammering, shaking or swabbing, or combination of methods.
- C. The system shall be purged with dry oil-free compressed air after erection. Oil free air is defined as containing less than 5 ppm oil with a 36°F or lower dewpoint. Use 80 to 90 psi pressure to purge system, unless otherwise indicated.
- D. Purge system at 12000 fpm velocity before installing any valves or control device. During the progress of construction, the open ends of pipe, fittings, and valves shall be properly protected to prevent the admission of foreign matter.
- E. Immediately after installation, valve outlets shall be closed with a threaded plug or cap and left closed until gas equipment is connected.

3.4 PRESSURE TESTING SYSTEM

- A. General: As a minimum pressure test system per NFPA 54 and UPC Chapter 12.
- B. For systems on which the normal operating pressure is 0.5 psig, the test pressure shall be 5.0 psig and the time interval shall be 30 minutes.

- C. For systems on which the normal operating pressure is 0.5 psig to 4.9 psig, the test pressure shall be 1.5 times the normal operating pressure or 5.0 psig, whichever is greater, and the time interval shall be 30 minutes.
- D. A pressure test using normal operating pressure shall be utilized only on systems operating at 5.0 psig or greater, and the time interval shall be one hour.
- E. Any interior piping failing the pressure test shall be repaired and retested or the piping shall be disconnected from the gas supply.
- F. Provide to owner a record of the system being tested after rough in and after completion of rough in to ensure operation and proper.

END OF SECTION