



Company Name:

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PURCHASING DEPARTMENT

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VOLUME 2 – TECHNICAL SPECIFICATIONS

RFB NO. 2023-099

**PROJECT MANUAL
FOR
CORRECTIONS CENTER AIR HANDLING UNIT
REPLACEMENT PROJECT**

100 N. Lamar Street
Fort Worth, TX 76196

**BIDS DUE MARCH 30, 2023
2:00 P.M.**

Technical Specifications Prepared by

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Fort Worth, TX 76116

RFB NO. 2023-099



Scope Summary

To: Bidders

Date: February 22, 2023

Subject: Tarrant County Corrections Center Replace Air Handling Units

Remove existing Air Handling Units, Smoke Exhaust Fans and Stairwell Pressurization Fans and replace with new Air Handling Units and Fans per the Drawings and Specifications.

1. The Mechanical Contractor for this project will be the Prime Contractor and will be responsible for ALL work on the project. The Mechanical Vendor will need to acquire ALL required subcontractors that are needed to complete all elements of the work. This will include, but not be limited to: Electrical work, Piping work and General Construction work. This will NOT include Controls work.
2. This contract to replace the Air Handling Unit equipment will be performed concurrently with a separate contract to replace the existing Building Automation System. The work for this contract will need to be performed in close coordination with the Building Automation System Contractor so that it will be installed as if one seamless project.
3. The Contractor for the Building Automation System replacement project will furnish certain control devices to this Contractor who will install them. This will include chilled water and heating water control valves and automatic control dampers and fire/smoke dampers.
4. This Contractor shall be responsible for developing a plan for removal of all demolished equipment from the building and delivery of all new equipment into the building via exterior louvers and/or freight elevator. Provide all cranes, rigging, etc, as required. Tarrant County Facilities Management and the City of Fort Worth will need to approve any street closures, etc.
5. The equipment replacement work, and related Building Automation System replacement work (performed under separate contract) will be performed on a Quadrant-by-Quadrant basis. When one Quadrant is down for replacement, all functions on the remaining 3 Quadrants must remain fully functional.
6. The First, Second, Third Floors and portion of the Fifth Floor will remain occupied during the duration of the project and will need to have Heating and Air Conditioning maintained at all times. Provisions for using temporary ductwork from other units while these units are replaced is indicated on the drawings.

7. Perform all work in accordance with all applicable National and Local Codes and Code Authorities.
8. Submit electronic copy of Shop Drawings for all materials furnished under this work.
9. Secure and pay for all necessary permits, licenses and inspections required by Law for the completion of the work. Secure and pay for all certificates of approval that are required and deliver them to the Engineer before final acceptance of the work.
10. Examine the project site and make allowances in the Bid to accommodate existing conditions.
11. All material shall be new, UL listed, and free from defects, unless existing material is specifically shown to be reused. Install all material in accordance with good workmanship standards.
12. Prior to bidding, any substitutions are to be submitted at the Question and Answer period. Reference Volume 1, Bottom of Page 3.
13. Provide factory finish on all material furnished to the jobsite and touch up finishes which have been damaged.
14. Schedule for removing existing units and installation of replacement units shall be carefully coordinated with Tarrant County Facilities Management prior to any work.
15. All equipment and accessories will be new.
16. Provide all electrical work required to support the new equipment in conformance with NEC requirements.
17. Most ceilings in the secure areas are $\frac{3}{4}$ " security cement plaster on metal lath. The Contractor will make any required ceiling openings for equipment access, install new access door and repair ceiling.
18. All Testing and Balancing work will be provided by the County's TAB Contractor, Air Balancing Company, and will not be included in the bid.
19. The Contractor should include a list of similar projects of this type, and also a list of projects within jail facilities. Provide a minimum of (2) references, with contact information, that can verify previous work within jail facilities.

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SECTION 23 00 10

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS AND SUPPLEMENTAL GENERAL PROVISIONS

- A. The "General Conditions" and "Supplementary Conditions" are by reference made a part of this section and shall apply to each and every heading as though included herein.
- B. In the event of conflict, the requirements of the "General Conditions" and "Supplementary Conditions" will take precedence over these "General Requirements".

1.2 GENERAL

- A. This contract to replace the existing Air Handling Units shall be performed concurrently with a separate project to replace the existing Building Automation System (BAS). The work for this contract shall be performed in close coordination with the Building Control System contractor so that it will be installed as if one seamless project, and shall fully comply with all Owner directed scheduling and phasing of work.
- B. The Contractor shall provide all plans, labor, equipment, appliances and materials, and shall perform all operations in connection with the installation of the mechanical work in accordance with the Specifications, applicable drawings, and the conditions specified above.
- C. Contractor shall furnish and install all equipment required to provide complete and operable systems, whether or not specifically mentioned or specifically indicated on the drawings.

1.3 COMMISSIONING

- A. All system commissioning will be performed in conjunction with the air balancing / commissioning company that will be Owner provided and not part of this contract.
- B. The Owner's Commissioning Agent will provide testing criteria and will perform inspections and functional tests with the assistance of a mechanical Contractor's technician familiar with the project.

1.4 INSPECTION OF THE SITE

- A. The Contractor shall visit the site, verifying all existing items indicated on drawings and/or specified, and become familiar with the existing work conditions, hazards, grades, actual formations, soil conditions, and local requirements. The submission of bids shall be deemed evidence of such visits.
- B. All proposals shall take these existing conditions into consideration, and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.
- C. In the event that equipment specified and/or reviewed is not compatible with the existing conditions, the trade furnishing the equipment shall be responsible for notifying the Contractor prior to ordering it.

1.5 PERMITS, UTILITY CONNECTIONS, AND INSPECTIONS

- A. Refer to other sections of the specifications for construction phasing and time increments.
- B. The Contractor shall obtain and pay for all required utility connections, utility extensions and/or relocations and shall pay all costs and inspection fees for all work included herein.

1.6 APPLICABLE CODES AND STANDARDS

- A. The installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of the Specifications, except as may be hereinafter modified in these Specifications and associated drawings.
- B. Latest edition of the National Fire Protection Association Standards (NFPA):
 - 1. NFPA No. 70 National Electrical Code
 - 2. NFPA No. 90A Installation of Air Conditioning and Ventilating systems
 - 3. NFPA No. 91 Exhaust systems of Air Conveying of Gases, etc.
 - 4. NFPA No. 96 Ventilation control and Fire Protection of Commercial Cooking Operations
 - 5. NFPA No. 101 Safety to Life from Fire in Buildings and Structures
 - 6. NFPA No. 255 Test of Surface Burning Characteristics of Building Materials
- C. United States of America Standards Institute (ASA) Standards:
 - 1. A40.8 National Plumbing Code
 - 2. B31.1 & B31.1a Code for Pressure Piping
- D. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes.
- E. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.
- F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) 1985: All applicable manuals and standards.
- G. Air Moving and Conditioning Association (AMCA): All applicable manuals and standards.
- H. American Society of Testing and Material (ASTM): All applicable manuals and standards.
- I. American Water Works Association (AWWA): All applicable manuals and standards.
- J. National Electrical Manufacturer's Association (NEMA): All applicable manuals and standards.
- K. City Fire Department as applicable to construction of this site.

- L. City and State Building Codes.
- M. State of (Texas) Occupational Safety Act: Applicable safety standards.
- N. Occupational Safety and Health Act (OSHA).
- O. State of (Texas) Energy Conservation Construction Code.
- P. All work shall be in accordance with all regulations and requirements of the State of Texas Architectural Barriers Act (TAS).
- Q. Refer to Specifications sections hereinafter bound for additional codes and standards.
- R. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. All material shall be listed by the Underwriter's Laboratories, Inc., as conforming to its standards and so labeled in every case where such a standard has been established for the particular type of material in question.
- S. All equipment provided and all installation methods shall meet all applicable requirements of the Fort Worth Energy Code and State Energy Code.
- T. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by other specifications of the Contract Documents, providing no work or fabrication of materials has been accomplished in a manner of non-compliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.7 CONTRACT DOCUMENTS

- A. These specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, switch controls, circuits, lines, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.
- B. If the Contractor deems any departures from the drawings necessary, details of such departures and the reasons therefore shall be submitted to the Engineer for review. No departures shall be made without prior written acceptance.
- C. There are intricacies of construction that are impractical to specify or indicate in detail; however, in such cases the current rules of good practice and applicable specifications shall govern.
- D. It is the Contractor's responsibility to properly use all information found on the Mechanical and Electrical drawings where such information affects his work.

- E. All dimensional information related to new structures should be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.
- F. The interrelation of the specifications, the drawings, and the schedules is as follows: The specifications determine the nature and setting of the several materials, the drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics.
- G. Should the drawings or specifications disagree within themselves, or with each other, the better quality of greater quantity of work or materials shall be estimated upon, and unless otherwise directed by the Engineer and Owner's Representative in writing, shall be performed or furnished. Figures indicated on drawings govern scale measurements and large-scale details govern small-scale drawings.

1.8 ACCESS DOORS

- A. This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed shutoff or service valves, dampers, VAV box access, and other items of concealed mechanical equipment. All access door locations are not shown on the drawings. It is the Contractor's responsibility to provide access doors at all locations required.
- B. Access Doors in Concrete Ceiling:
 - 1. Flat frame 10 gauge steel security access door.
 - 2. Frame: 2 in. x 2in. x 3/16 in. angle frame with 2 in. flange, welded at corners.
 - 3. Door: 10 gauge plate steel door mounted on two heavy-duty detention hinges welded to frame. Size as required, with minimum 18" x 18" size.
 - 4. Finish: Grey powder coat paint.
 - 5. Lock: In lieu of lock, secure door with (8) stainless steel Torx security screws evenly distributed around 3 sides. Verify compatibility with Owner's current security screws.
 - 6. Equal to SP Series by JL Industries.
- C. Access Doors in Sheet Rock Ceiling:
 - 1. Frame: 16 gauge steel with 1 in. well flange.
 - 2. Door: 16 gauge steel access door mounted with a 90° continuous, concealed hinge. Size as required, with minimum 18" x 18" size.
 - 3. Finish: Grey powder coat paint.
 - 4. Lock: In lieu of lock, secure door with (8) stainless steel Torx security screws evenly distributed around 3 sides. Verify compatibility with Owner's current security screws.
 - 5. Equal to TM Series by JL Industries.

1.9 SPACE AND EQUIPMENT ARRANGEMENT

- A. The size of mechanical and electrical equipment indicated on the drawings is based on the dimensions of the manufacturer used as the basis of design. While other manufacturers

may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Shop drawings shall be prepared to indicate a suitable arrangement.

- B. All equipment shall be installed in a manner that will allow required access. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.
- C. Maintain all code required clearances for equipment access.

1.10 FABRICATION DRAWINGS

- A. Contractor shall submit shop drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit and other equipment, and (3) where called for elsewhere in these specifications.
- B. All required shop drawings, except as hereinafter specified, shall be prepared at a scale of not less than 1/4 in. equal to 1 ft. for floor plans and 1/4 in. equal to 1 ft. for mechanical rooms.

1.11 SUPERVISION

- A. Each contractor shall keep a competent superintendent or foreman on the job at all times necessary for the timely and proper completion of the work.
- B. It shall be the responsibility of each superintendent to study all drawings and familiarize himself with the work to be done by other trades. He shall coordinate this work with other trades, and before material is fabricated or installed, make sure that his work will not cause an interference that cannot be resolved without major changes to the drawings. If a conflict between trades arises that cannot be resolved at the jobsite, the matter shall be referred to the Engineer and Owner's Representative for his ruling.

1.12 EXISTING FACILITIES

- A. The Contractor shall be responsible for loss or damage to the existing facilities caused by any workers 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 in-service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, and remove all such temporary protection upon completion of the work. All barricades and safety devices shall be in compliance with OSHA.
- B. The Contractor shall provide temporary or new services to all 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. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

- D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall, in locations approved by the Engineer and Owner's Representative, all devices required for the operation of the various systems installed in the existing construction. This is to include, but is not limited to, temperature control system devices, electrical switches, relays, fixtures, piping, conduit, etc.
- E. Outages of services, as required by the new installation, will be permitted only at a time approved by the Engineer and Owner's Representative.

1.13 DEMOLITION AND RELOCATION

- A. The Contractor shall modify, remove and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition.
- B. All items that are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.
- C. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed and sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Engineer. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas of facilities, which must remain in operation during the construction period, shall not be interrupted without prior specific approval of the Engineer as hereinbefore specified.
- D. All equipment and materials indicated to be removed and not be re-used shall be disposed of by the Contractor.

1.14 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall prepare, in triplicate for the Owner's Manual, complete sets of operating and maintenance instructions, system piping, valving, control and interlock diagrams, manuals, parts lists, etc., for each item of equipment. Include copies of all equipment warranties.
- B. In addition, the Contractor shall provide the services of a competent certified technician to instruct the Owner in the complete and detailed operation of all equipment and systems. These instructions shall be provided for a period of not less than 8 hours to fully accomplish the desired results. Upon completion of these instructions, a letter of release will be required, stating the dates of instruction and the personnel to whom instructions were given. The Contractor shall be responsible for proper maintenance until the instructions have been given to the Owner's maintenance personnel.

1.15 GUARANTEE

- A. All work and equipment shall be guaranteed for a period of one year from the date of substantial completion.
- B. Guarantee shall be for all labor and materials.

1.16 MATERIALS AND WORKMANSHIP

- A. All materials, unless otherwise specified, shall be of current U.S. manufacture, new, free from all defects, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall present a neat, workmanlike appearance. Materials, and/or equipment damaged in shipment, or otherwise damaged prior to installation, shall not be repaired at the job site, but shall be replaced with new materials and/or equipment.
- B. The responsibility for furnishing the proper equipment and/or material, and to see that it is installed as intended by the manufacturer rests entirely upon the Contractor, who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.17 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA 255, latest edition. The classification shall not exceed No. 2, with the range of indices between 0 to 25 for these Classifications as listed in the Federal Specifications. Modifications shall be made to insulating materials, etc., as required to comply with the Federal Specification.

1.18 LARGE APPARATUS

- A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed into the building in pieces, via existing exterior wall louvers. Following placement in the space, such apparatus shall be re-assembled thoroughly, completely protected from damage as hereinafter specified.

1.19 CONSTRUCTION REQUIREMENTS

- A. The Mechanical and Electrical plans and specifications including the General Provisions, Supplemental General Provisions, and other pertinent documents issued by the Architect, are a part of these specifications and the accompanying mechanical drawings, and shall be complied with in every respect. All the above is included in the Contract Documents, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of architectural, structural and electrical details from the mechanical drawings.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and

equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.

- C. The Contractor shall be responsible for fitting all material and apparatus into the building and shall carefully lay out all work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation supplied by the manufacturer of the equipment to be installed and thereby to provide an integrated satisfactory operating installation.
- D. The mechanical and associated drawings are necessarily diagrammatic in character and cannot show every connection in detail or every pipe or equipment in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate pipe hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- E. When the mechanical drawings do not give exact details as to the elevation of pipe, ducts, etc., physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Piping and duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner, and the plans do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas. Piping specified to be insulated shall be supported in a manner that will allow the insulation to be installed without gaps. Insulated piping in concealed areas shall be offset with fittings as necessary to permit installation of insulation. Bending of pipes or installing pipes in a strain in order to insulate will not be permitted.
- F. All oiling devices and all parts of equipment requiring adjustment shall be easily accessible. Equipment shall be so located and installed as to permit convenient and safe maintenance and future replacement. Piping, ductwork, valve stems, etc., shall not block service space.

1.20 MECHANICAL SUBMITTALS

- A. Refer to the Conditions of the Contract (General and Supplementary) and Division 01 Section: "SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES" for submittal definitions, requirements, and procedures.
- B. Submittal of Shop Drawings, product data, and samples will be accepted only when submitted by The Contractor. Data submitted from Subcontractors and material suppliers directly to the Engineer will not be processed.
- C. Submit Shop Drawings, product data, and samples on items indicated in the individual sections.
- D. Shop Drawings and submittal data shall not be used as requests or proposals for alternate equipment or materials. Refer to Item "Product Options and Substitutions" elsewhere in this section.

1.21 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and the Division 01 Section "PRODUCTS AND SUBSTITUTION" for requirements in selecting products and requesting substitutions.
- B. Standards for Materials:
1. These specifications indicate a standard for all materials incorporated into the work, with manufacturer's names and catalog numbers used to establish a grade and quality of materials and equipment. The manufacturer listed on the equipment schedules, or named first in the specifications, is the one on whose equipment the layout is based. Other named manufacturers must meet the indicated performance and space requirements.
 2. The "approved equal" clause used in these specifications is to permit the proposal of unnamed manufacturer's products for the work, and the Engineer and Owner's Representative decision concerning equal products is final.
 3. Considerations as to determination of equal products include, but are not limited to, the following:

Materials	Physical size
Workmanship	Weight
Gauges of Materials	Appearance
Available Local Service Personnel	Performance
Previous successful installations	Capacity
Delivery Schedules	Required Equipment Clearances
- C. Requests for substitutions of equipment, materials and apparatus listed in Division 23 Sections must be submitted in writing as a question during the prescribed timeframe for submitting questions. Refer to the instructions for bidders for timeframe. Such requests must be accompanied by complete data to permit proper evaluation. Such requests must be accompanied by complete data to permit proper evaluation.
- D. BIDS SHALL NOT BE BASED ON UN-APPROVED MATERIALS, EQUIPMENT, OR APPARATUS. UNAPPROVED MATERIAL, EQUIPMENT OR APPARATUS WILL NOT BE ACCEPTED.
- E. Should electrical, water, drain, natural gas, structural support, or other similar requirements for alternate equipment, whether named in the specifications or approved as a substitution, be different from requirements for the products used in laying out the project, such changes shall be the responsibility of the Contractor, and shall not result in extra charges to the Owner or Engineer.

1.22 RECORD DOCUMENTS

- A. Refer to the Division 01 Section: "CLOSEOUT PROCEDURES" for requirements. The following paragraphs supplement the requirements of Division 01.
- B. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned for column lines; mains and branches of piping systems, with valves and

control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

- C. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.23 PAINTING

- A. Protection of Factory-applied Finishes:
 - 1. Factory-applied finishes on equipment and apparatus installed on the project shall be carefully protected.
 - 2. At the conclusion of the work, and prior to final acceptance of the project, equipment and apparatus shall be thoroughly cleaned of all construction dirt, oil and grease smears, temporary labels, debris, paint droppings, etc.
 - 3. Damaged factory finishes shall be restored to their original condition using procedures, materials and application techniques as set forth in Division 09 found elsewhere in these specifications.

1.24 CLEANING

- A. Refer to the Division 01 Section: "CLOSEOUT PROCEDURES" for general requirements for final cleaning.
- B. Refer to Division 23 Section: "TESTING, ADJUSTING, AND BALANCING" for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.
- C. Name Plates:
 - 1. All nameplates shall be protected from damage during the construction process.
 - 2. At the conclusion of the work, the nameplates shall be carefully cleaned and left in a fully legible condition.
- D. Removal of Rubbish: Each Contractor is responsible for the timely removal of rubbish and trash generated by his work, such as empty cartons, containers, materials crates, etc., from the project site Particular attention is called to residue that may present a potential tripping or injury hazard.

1.25 MOTORS AND DRIVES

- A. Motors:
 - 1. General: Motors shall be U/L-approved, with copper windings, and with a minimum Service Factor of 1.15. The nominal capacity shall exceed the brake horse-power requirements at duty schedules.
 - 2. Motors 1/2 HP and smaller shall be 120-volt, single-phase with internal overload protection.
 - 3. Motors 3/4 HP and larger shall be 208/230 or 460 -volt, 3-phase, unless scheduled or noted otherwise, and shall have thermal over-load cutouts in each phase as recommended by the motor manufacturer.

4. Motors shall be as manufactured by Century, General Electric, US Motors, Wagner, Westinghouse, or approved equal.

B. Drives:

1. Belts drives shall be rated for 150% of motor-rated horsepower.
2. Drive assemblies up to two (2) belts shall have adjustable motor sheaves with the mid-point of the adjustment range at the RPM required for the specified performance. Any motor controlled by a VFD does not need adjustable sheave.
3. On drive assemblies with 3 or more belts, provide fixed motor sheaves for the specified RPM. Provide and install up to 2 pulley changes as necessary to achieve the required air quantities.
4. All multiple-belt drives shall be factory-marked-matched sets.

C. Specific requirements:

1. Provide high-efficiency motors for the following:
 - a. Air-Handling Units, as scheduled.
 - b. Ventilating Fans, as scheduled.
 - c. HVAC Pumps, as scheduled.
2. All motors driven by VFD are capable of operating at 80 Hz.
3. Efficiency ranges shall be as follows:

Nominal HP	Minimum Efficiency	Premium Efficiency
3	86.5	89.5
5	87.5	89.5
7.5	88.5	91.7
10	89.5	91.7
15	91.0	92.4
20	91.0	93.0
25	91.7	93.6
30	92.4	93.6
40	93.0	94.1
50, 60, 75	93.0, 93.6, 94.1	94.5, 95.0, 95.4
100	94.1	95.4

Motor efficiency certification shall be included with Product Submittal Data in accordance with Division 01 of these specifications.

4. Variable Speed (Frequency) AC Drives:
 - a. Where scheduled on the plans, provide and install variable speed (frequency) AC drives for motors.
 - b. Variable speed (frequency) AC drives shall be as described in Section 23 89 65 - MOTOR CONTROLLERS - of these Specifications.
5. Motor Starters and Controllers:
 - a. Motor starters and controllers for fans, pumps, air-handling units, compressors, etc., which are not provided as an integral part of a factory-assembled package, shall be provided under Division 23 of the specifications. Refer to Section 23 89 65 "MOTOR CONTROLLERS."

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

- A. The manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer's materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Engineer and Owner's Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturer's directions and shall obtain the Engineer and Owner's Representative instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Engineer and Owner's Representative, he shall bear all costs arising in connection with the deficiencies.
- B. The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.
- C. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions.
- D. Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriter's Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under these sections of the specifications conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.
- E. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Observation.
- F. Standard factory finish will be acceptable on equipment specified by model number; otherwise surfaces of ferrous metal shall be given a rust-inhibiting coating. The treatment shall withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking, and no signs of rust creepage beyond 1/8 in. on either side of the scratch mark. Where rust-inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable, unless a specific coating is specified, except that coal tar or asphalt type coatings will not be acceptable, unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-6215.
- G. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts located so that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.
- H. The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiarize with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Engineer and Owner's Representative of

any discrepancy before performing any work. Adjustments to the work required, in order to facilitate a coordinated installation, shall be made at no additional cost to the Owner.

2.2 PROTECTION

- A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.
- B. Take particular care not to damage the building structure in performing work. All finished floors, steel treads, and workmen or their tools and equipment shall cover finished surfaces to prevent any damage during the construction of the building.
- C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final observation must be cleaned of rust and repainted as specified elsewhere in these specifications.

2.3 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

EACH TRADE, SUBCONTRACTOR AND/OR CONTRACTOR MUST WORK IN HARMONY WITH THE VARIOUS OTHER TRADES, SUBCONTRACTORS, AND/OR CONTRACTORS ON THE JOB AS MAY BE REQUIRED TO FACILITATE THE PROGRESS TO THE BEST ADVANTAGE OF THE JOB AS A WHOLE. EACH TRADE, SUBCONTRACTOR, AND/OR CONTRACTOR MUST PURSUE HIS WORK PROMPTLY AND CAREFULLY AS NOT TO DELAY THE GENERAL PROGRESS OF THE JOB. THIS CONTRACTOR SHALL WORK IN HARMONY WITH CONTRACTORS WORKING UNDER OTHER CONTRACTS ON THE PREMISES.

2.4 PRECEDENCE OF MATERIALS

- A. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structural design of the building, which will fit into the available space, and which will insure complete and satisfactory systems. Each Contractor shall be responsible for the proper fitting of his material and apparatus into the building.
- B. Each Contractor shall so harmonize all work with the work of the other trades so that it may be installed in the most direct and workmanlike manner without hindering, interfering, restricting the other trades. Piping interferences shall be handled by giving precedence to pipelines that require a stated grade for proper operation.

PART 3 - INSTALLATION

3.1 INSTALLATION METHODS

- A. Piping may be run exposed in mechanical rooms, janitors' closets, or storage spaces, but only where necessary. All exposed piping shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines.

- B. All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.
- C. Where limited space is available above the ceilings and below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, in a manner to provide maximum above-floor clearance. Sleeves shall be as specified or as required.
- D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run, exposed in machinery and equipment rooms, shall be installed parallel to the building plans, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces may be run at angles to the construction but shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.
- E. There shall be no pipe joints nearer than 12 in. to a wall, ceiling, or floor penetration, unless pipe joint is the welded type joint.
- F. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces. Where conflicts occur, the Contractor shall meet with all involved trades and the Engineer and Owner's Representative and resolve the conflict, prior to erection of any work, in the area involved.

3.2 FABRICATION OF PIPE

- A. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage.
- B. Piping shall follow as closely as possible the routes shown on plans, but shall take into consideration conditions to be met at the site.
- C. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after approval has been obtained.
- D. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which lines are connected.
- E. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage shall be removed. Pipe shall not be permitted to lie on the ground during storage. Pipe ends shall be sealed during storage.

3.3 IDENTIFICATION AND LABELING

- A. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them.

- B. All items of mechanical and electrical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16 in. thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/2 in. high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include, but not be limited to, the following:
1. Air Handling Units
 2. Exhaust Fans
 3. Pressurization Fans
 4. Roof mounted fans
 5. Air conditioning control panels and switches
 6. Motor controllers
 7. Miscellaneous similar and/or related items.
- C. The Contractor shall install identification tags to be affixed to those valves that have functions that are not obvious. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. The valve identification tags shall be brass discs, 2 in. in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

3.4 TESTS AND INSPECTIONS

- A. The Contractor shall, during the progress of the work and upon its completion, test his work and make all tests as required by the specifications, state, municipal and other authorities having jurisdiction of the work. Piping pressure tests shall be made before pipe is concealed or covered. Tests shall be made in the presence of authorities requiring tests. The Contractor shall pay all costs, inspection charges and fees required for the tests of his work.
- B. The Contractor shall provide all apparatus, temporary piping connection, etc., required for tests. The Contractor shall take all due precautions to prevent damage to the building or its contents incurred by such tests. The Contractor shall repair and make good at his own expense any damage caused by failures or leaks during the tests.
- C. Leaks, defects or deficiencies shall be repaired and/or replaced, and tests shall be repeated until the test requirements are complied with fully.
- D. All equipment shall be placed in operation and tested for proper automatic control before the final balancing of the system is started.
- E. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description, and extent of system tested, test condition, test results, specified results, and any other pertinent data. Data shall be delivered to the Engineer and Owner's Representative.

3.5 COOPERATION AND CLEANUP

- A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by his portion of the work.

3.6 CLEANING AND PAINTING

- A. All equipment, piping, ductwork, grills, insulation, etc., in finished areas furnished and installed by the Contractor shall be painted. Finished areas include mechanical rooms, boiler rooms, and outside the building as well as occupied areas inside the building. Final painting is to be done by the General Contractor. This Contractor shall thoroughly clean all part of materials and equipment of cement, plaster, and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean.
- B. This Contractor shall thoroughly clean the finish on all parts of the materials and equipment with factory applied finishes. Exposed parts in equipment rooms, above crawl space slabs, and all other spaces except sealed chases and attics shall be thoroughly cleaned of cement, plaster and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. If the finish has been damaged, the Contractor shall re-paint to the satisfaction of the Engineer and Owner's Representative.
- C. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during painting operation.

3.7 ELECTRICAL PROVISIONS OF MECHANICAL WORK

- A. The extent of electrical provisions to be provided as mechanical work is indicated in other mechanical sections of the specifications, on the drawings and as further specified in this section.
- B. Starters, Controllers: In general, mechanical work includes furnishing combination starters. Controllers are specifically included as electrical work when mounted in motor control centers. Electrical work includes installation, mounting and wiring of starters and controllers that are furnished as mechanical work. Free standing, large motor controllers shall be set in place, on pads, as mechanical work.
- C. Electrical heating equipment shall be furnished complete with internal or integral fusing and subdivision of loads to comply with the NEC.
- D. Wherever possible, match the elements of the electrical provisions of mechanical work with similar elements of the electrical work specified in electrical sections of the specifications.
- E. Standards:
 - 1. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards to definitions of terminology herein.

2. Comply with National Electrical Code (NFPA No. 70) for installation requirements.
3. Comply with National Electrical Contractors Association (NECA) "Standard of Installation".

3.8 TEMPORARY FACILITIES

- A. Unless noted otherwise in the Supplementary General Conditions; provide temporary facilities.

3.9 EQUIPMENT INSTALLATION REQUIREMENTS

- A. All mechanical equipment shall be furnished and installed complete and ready for use.
- B. All mechanical equipment and appliances shall be installed in a manner that all Code required access and services space is provided. Coordinate exact position of equipment and appliances with routing of new ductwork and piping, and with all existing conditions to provide required clearances.
 1. Ensure that a minimum of 30" deep and 30" wide working space is provided in front of the control side of each appliance and piece of air moving equipment.

END OF SECTION

SECTION 23 05 12

MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Refer to Section 23 00 10 - BASIC MECHANICAL REQUIREMENTS.

1.2 SUMMARY

- A. This Section describes the coordination between the Fire Protection, Plumbing, Mechanical and Electrical portions of the work.
- B. This Section is included under the Division 21 portion of the Specifications as Section 21 05 12, under the Division 22 portion of the Specifications as Section 22 05 12, under the Division 23 portion of the Specifications as Section 23 05 12, and under the Division 26 portion of the Specifications as Section 26 05 12.

1.3 WORK INCLUDED

- A. Responsibility: Unless otherwise indicated, motors and controls shall be furnished, set in place and wired in accordance with the following schedule. **This schedule may include equipment and systems that are not required for this project. Only the equipment and systems that are required on the drawings and/or specified elsewhere will be required by this section:**

ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
1. Equipment Motors	21/22/23	21/22/23	26
2. Magnetic Motor Starters			
a. Automatically controlled, with or without HOA switches	21/22/23	26	Notes 1,3,5
b. Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	21/22/23	22/23	Notes 1,3,5
c. Manually controlled	21/22/23	26	Notes 1,3,5
d. Manually controlled and furnished as part of factory wired equipment	21/22/23	26	Notes 1,3,5
e. Furnished in Motor Control Centers	26	26	Notes 1,3,5
3. Variable Speed (Frequency) AC Drives	22/23	26	Notes 1,4,5
4. Line voltage thermostats, time clocks, etc., not connected to control panel systems	23	26	23

ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
5. Electric thermostats, time clocks, remote bulb thermostats, motorized valves, float controls, etc. which are an integral part or directly attached to ducts, pipes, etc.	22/23	22/23	22/23
6. Temperature control panels and time switches mounted on temperature control panels	23	23	23
7. Motorized valves, motorized dampers, solenoid valves, EP and PE switches, etc.	23	23	Note 1
8. Alarm bells furnished with equipment installed by Division 22 or 23	22/23	22/23	22/23
9. Wiring to obtain power for control circuits, including circuit breaker	21/22/23	21/22/23	21/22/23
10. Low voltage controls	21/22/23	21/22/23	21/22/23
11. Fire protection system (sprinkler) controls	21	21	Note 8
12. Fire and smoke detectors installed on mechanical units and in ductwork	28	23	Note 8
13. All relays required for fan shutdown, motorized dampers, smoke control devices, and other items integral with HVAC equipment to provide operation and control of HVAC equipment	23	23	Note 1
14. Smoke dampers, and combination fire/smoke dampers	23	23	Note 7
15. Boiler and water heater controls, boiler burner controls panels	22/23	22/23	22/23
16. Pushbutton stations, pilot lights	22/23	22/23	22/23
17. Heat Tape	21/22/23	21/22/23	26
18. Disconnect switches, manual operating switches furnished as a part of the equipment	21/22/23	21/22/23	Notes 1,5
19. Disconnect switches, manual operating switches furnished separate from equipment	26	26	26
20. Multispeed switches	23	23	26
21. Thermal overloads	21/22/23	21/22/23	21/22/23
22. Control relays, transformers	21/22/23	21/22/23	21/22/23
23. Refrigeration cycle, cooling tower and controls	23	23	23
24. Tamper switches for fire protection (sprinkler) system	21	21	28
25. Flow and/or pressure switches for fire protection (sprinkler) system	21	21	28
26. Alarm bells or horns for fire protection (sprinkler) system	21	21	28

- NOTES:
- (1) Power wiring as defined in Section 26 29 13 of the specifications shall be provided under Division 26; control wiring as defined in Section 26 29 13 of the specifications shall be provided under Division 21/22/23.
 - (2) Wiring from alarm contacts to alarm systems provided by Division 26, wiring from auxiliary contacts to air handling system controls provided by Division 23. Division 26 shall provide power to smoke detector. Smoke detectors required for all air handling systems 2000 CFM or greater. Refer to other Division 23 specifications, Division 26 and Drawings for more specific requirements.
 - (3) For requirements for Magnetic Motor Starters, refer to Section 23 89 65 - MOTOR CONTROLLERS.
 - (4) For requirements for Variable Speed (Frequency) AC drives, refer to Section 23 89 65 - MOTOR CONTROLLERS.
 - (5) Disconnect switches, operating switches, starters and other similar items that are factory-mounted, as a part of complete assembly, shall comply with applicable provisions of the National Electric Code. All such disconnect switches shall be fused.
 - (6) Power wiring from energy source to controllers and automatic transfer switch shall be provided under Division 26. Interconnection power and control wiring from controllers and automatic transfer switch to pumps shall be provided under Division 21, 22 or 23 and conforming to Division 26 specifications. Control wiring from automatic transfer switch to generator starter shall be provided under Division 26.
 - (7) Division 26 will provide power to all smoke and combination fire/smoke dampers, and Division 28 will provide control for all such dampers using area smoke detectors.
 - (8) Wiring for sprinkler system controls to be provided by Division 21. Wiring from devices to Fire Alarm System to be provided by Division 28.

B. CONNECTIONS: Make all connections to controls that are directly attached to ducts, piping and mechanical equipment with flexible connections.

C. PRECEDENCE

1. In general, piping systems that require a stated grade for proper operation shall have precedence over other systems.
2. Precedence for pipe, conduit and duct systems shall be as follows.
 - a. Building lines
 - b. Structural members
 - c. Soil and drain piping
 - d. Vent piping
 - e. Steam piping
 - f. Condensate piping
 - g. Refrigerant piping
 - h. Electrical bus duct
 - i. Supply ductwork
 - j. Return ductwork
 - k. Exhaust ductwork
 - l. Chilled water and heating water piping
 - m. Automatic Fire Protection Sprinkler Piping
 - n. Natural gas piping
 - o. Domestic hot and cold water piping
 - p. Electrical conduit
3. Lighting Fixtures shall have precedence over air grilles and diffusers.

D. FINAL INSPECTION AND REPORT

1. At the completion of the work, there shall be a meeting of the Fire Protection, Plumbing, Mechanical, Electrical Fire Alarm and Temperature Control Contractors, representatives of mechanical and electrical equipment manufactures whose equipment was actually installed on the project, and similarly-involved individuals, who shall thoroughly inspect all systems, and who shall mutually agree that all equipment has been properly wired and installed, and that all temperature and safety controls are properly functioning. A written report of this meeting, listing those in attendance, and the companies that they represent, shall be filed with the Owner and Engineer.

END OF SECTION

SECTION 23 05 19

MECHANICAL METERS AND GAUGES

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of meters and gauges required by this section is indicated on Drawings and/or specified in other Division 23 sections.
- B. Types of meters and gauges specified in this section include the following:
 - 1. Temperature Gauges and Fittings.
 - a. Glass Thermometers.
 - b. Thermometer Wells.
 - 2. Pressure Gauges and Fittings.
 - a. Pressure Gauges.
 - b. Pressure Gauge Cocks.
- C. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of meters and gauges, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.
 - 2. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
- B. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.1 GLASS THERMOMETERS

- A. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9 in. long.
- C. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
- D. Tube and Capillary: Glycerin-filled, magnifying lens, 1 percent scale range accuracy, shock mounted.
- E. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
- F. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.
- G. Range: Conform to the following:
 - 1. Hot Water: 30° - 240°F with 2°F scale divisions (0° - 160°C with 2°C scale divisions).
 - 2. Chilled Water: 30° - 180°F with 2°F scale divisions (0° - 100°C with 1°C scale divisions).
- H. Manufacturer: Subject to compliance with requirements, provide glass thermometers of one of the following, or approved equal.
 - 1. Ernst Gage Co.
 - 2. Marshalltown Instruments, Inc.
 - 3. Trerice (H.O.) Co.
 - 4. Weiss Instruments, Inc.
 - 5. Weksler

2.2 THERMOMETER WELLS

- A. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2 in. extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
- B. Manufacturer: Same as thermometers.

2.3 PRESSURE GAUGES

- A. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

- B. Type: General use, glycerin-filled, magnifying lens, 1% accuracy, ANSI B40.1 grade A, phosphor bronze bourdon type, bottom connection.
- C. Case: Drawn steel or brass, glass lens, 4+ in. diameter.
- D. Connector: Brass with 1/4 in. male NPT. Provide protective siphon when used for steam service.
- E. Scale: White coated aluminum, with permanently etched markings.
- F. Range: Conform to the following:
 - 1. Water: 0 - 100 psi.
- G. Manufacturer: Subject to compliance with requirements, provide pressure gauges of one of the following, or approved equal:
 - 1. Ametek/U.S. Gauge.
 - 2. Marsh Instrument Co.; Unit of General Signal.
 - 3. Marshalltown Instruments, Inc.
 - 4. Trerice (H.O.) Co.
 - 5. Weiss Instruments, Inc.

2.4 PRESSURE GAUGE COCKS

- A. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4 in. female NPT on each end, and "T" handle brass plug.
- B. Siphon: 1/4 in. straight coil constructed of brass tubing with 1/4 in. male NPT on each end.
- C. Snubber: 1/4 in. brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
- D. Manufacturer: Same as for pressure gauges.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF TEMPERATURE GAUGES

- A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.

- B. Locations: Install in the following locations, and elsewhere as indicated:
 - 1. At inlet and outlet of each hydronic coil in air handling units.
- C. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

3.3 INSTALLATION OF PRESSURE GAUGES

- A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated:
 - 1. At suction and discharge of each pump.
 - 2. At discharge of each pressure reducing valve.
 - 3. At water service inlet.
 - 4. At inlet and outlet at each hydronic coil in handling units.
- C. Pressure Gauge Cocks: Install in piping tee with snubber. Install siphon for steam pressure gauges.

3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 05 29

MECHANICAL SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of supports and anchors required by this section is indicated on Drawings and/or specified in other Division 23 sections.
- B. Types of supports and anchors specified in this section include the following:
 - 1. Pipe and equipment hangers, supports, and anchors.
 - 2. Equipment bases.
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Code Compliance: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
 - 2. Fire Protection Compliance: Install in accordance with NFPA 13-latest edition. Provide products that are UL-listed and FM approved.
 - 3. MSS Standard Compliance:
 - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - b. Select and apply pipe hangers and supports, complying with MSS SP-69.
 - c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
 - d. Terminology used in this section is defined in MSS SP-90.
- C. All hangers, supports and attachments shall be manufactured with materials compatible with the environment in which they will be installed. Unless directed otherwise, all hangers, supports, and attachments installed exterior to the building or within high humidity environments shall be galvanized steel or stainless steel.
- D. Manufacturers of Hangers and Supports:
 - 1. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - a. B-Line Systems Inc. (Cooper)
 - b. ANVIL International

1.3 SUBMITTALS

- A. Submit product data as required under provisions of Division 01 and Section 23 00 10.
- B. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

PART 2 - PRODUCTS

2.1 HORIZONTAL-PIPING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit around piping insulation with saddle or shield for insulated piping.
- B. Adjustable Steel Clevis Hangers: MSS Type 1.
- C. Steel Pipe Clamps: MSS Type 4.
- D. Pipe Hangers: MSS Type 5.
- E. U-Bolts: MSS Type 24.
- F. Pipe Saddle Supports: MSS Type 36, including steel pipe base-support and cast-iron floor flange.
- G. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.
- H. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.

2.2 HANGER-ROD ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
- B. Steel Turnbuckles: MSS Type 13.
- C. Steel Clevises: MSS Type 14.
- D. Swivel Turnbuckles: MSS Type 15.

- E. Malleable Iron Sockets: MSS Type 16.

2.3 BUILDING ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
- B. Top Beam C-Clamps: MSS Type 19.
- C. Side Beam or Channel Clamps: MSS Type 20.
- D. Center Beam Clamps: MSS Type 21.
- E. Welded Beam Attachments: MSS Type 22.
- F. C-Clamps: MSS Type 23.
- G. Top Beam Clamps: MSS Type 25.
- H. Side Beam Clamps: MSS Type 27.
- I. Steel Beam Clamps W/Eye Nut: MSS Type 28.
- J. Linked Steel Clamps W/Eye Nut: MSS Type 29.
- K. Malleable Beam Clamps: MSS Type 30.
- L. Steel Brackets: One of the following for indicated loading:
 - 1. Light Duty: MSS Type 31, suspending 750 lbs. max.
 - 2. Medium Duty: MSS Type 32, suspending 1500 lbs. max.
 - 3. Heavy Duty: MSS Type 33, suspending 3000 lbs. max.
- M. Side Beam Brackets: MSS Type 34.
- N. Plate Lugs: MSS Type 57.

2.4 CONCRETE INSERTS

- A. Cast-In-Place Spot Type: Malleable iron, or steel with recommended insert nut. Size inserts nut to suit threaded hanger rod. MSS SP-69, Type 18.
- B. Drill-In Spot Type: Steel, attached wedge, lock washer and nut. Size inserts to suit threaded hanger rod.
 - 1. Acceptable Manufacturers and Models:
 - a. Hilti "Kwik Bolt"

- b. Ramset "Wedge Anchor"
- c. Rawl "Stud"

C. Continuous Channel Type: Steel, anchoring lugs, with channel nuts, rated for 2000 lbs. per foot minimum load. Size channel nut to suit threaded hanger rod.

- 1. Acceptable Manufacturers and Models:
 - a. B-Line B22
 - b. Elcen 1150
 - c. Unistrut P3200

2.5 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
- B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
- C. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
- D. Thermal Hanger Shields: Constructed of 360° insert of high density, 125-psi compressive strength, and water-proofed calcium silicate, encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation.
 - 1. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following:
 - a. Elcen Metal Products Co.
 - b. Pipe Shields, Inc.

2.6 MISCELLANEOUS MATERIALS

- A. Metal Framing: Provide products complying with NEMA STD ML 1.
- B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
- D. Auxiliary Steel: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

2.7 CONCRETE HOUSEKEEPING BASES

- A. Concrete housekeeping bases shall be in accordance with Division 3 and constructed of 4,000 psi concrete and reinforced with welded wire fabric in accordance with ASTM A 185 or deformed reinforcing bar in accordance with ASTM A 615, Grade 60.
- B. Reinforcement shall be provided for base thickness as follows unless otherwise noted.

Thickness of Base	Size and Type of Reinforcement	Spacing and Location of Reinforcement
4 in.	W 2.9 x 2.9 welded	6 in. x 6 in. at centerline of pad

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.3 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at all changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Install additional at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at all changes in direction of piping. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

- C. Prevent electrolysis in support of copper tubing by use of hangers and supports that are copper plated, or by other recognized industry methods.
- D. Support and laterally brace vertical pipe runs at every floor level and at intervals not to exceed 20 ft. 0 in. Support vertical pipe with riser clamps installed below hubs, couplings or lugs welded to the pipe.
- E. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
 - 2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
- F. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Piping hangers shall be sized large enough to allow insulation to pass through. Hangers for piping 2-1/2 in. and greater shall be provided with pipe covering protection saddle, or high compressive strength insulation saddle. Hangers for piping 2 in. and less shall be provided with pipe covering shields. On cold or chilled water piping provide vapor barrier through hanger.
 - 3. Do NOT utilize "pipe size" hangers or clamps with insulation placed over the pipe and hanger or clamp.
- G. Unless directed otherwise, all hangers, supports, and attachments installed exterior to the building or within high humidity environments shall be galvanized steel or stainless steel.

3.5 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
- C. Anchor spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 CONCRETE HOUSEKEEPING BASES

- A. Provide concrete housekeeping bases for all floor-mounted equipment furnished as part of the work of Division 23 in accordance with Division 03. Size bases to extend minimum of 4 in. beyond equipment base in any direction; and 4 in. above finished floor elevation, unless

otherwise noted on Drawing. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

3.7 ADJUSTING AND CLEANING

- A. Hanger Adjustments: Adjust hangers so as to distribute loads equally on attachments.
- B. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 05 48

MECHANICAL VIBRATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of vibration control work required by this section is indicated on Drawings and schedules, and/or specified in other Division 23 sections.
- B. Types of vibration control products specified in this section include the following:
 - 1. Neoprene Pads
- C. Vibration control products furnished as integral part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.
- D. Refer to other Division 23 sections for equipment foundations, hangers, sealants, gaskets, and other work related to vibration control work.
- E. Refer to other Division 23 sections for requirements of electrical connections to equipment isolated on vibration control products.
- F. Refer to other Division 23 sections for requirements of duct connections to air handling equipment isolated on vibration control products.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Except as otherwise indicated, obtain vibration control products from single manufacturer.
- C. Engage manufacturer to provide technical supervision of installation of vibration control products.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of vibration control product. Submit schedule showing size, type, deflection, and location for each product furnished.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Submit to compliance with requirements; provide vibration control products of one of the following:
 - 1. Amber/Booth Co.

2. Consolidated Kinetics, Inc.
3. Korfund Dynamics Corp.
4. Mason Industries, Inc.
5. Peabody Noise Control, Inc.
6. Vibration Eliminator Co., Inc.
7. Vibration Mountings and Controls, Inc.

2.2 VIBRATION CONTROL MATERIALS AND SUPPORT UNITS:

- A. Neoprene Pads: Oil-resistant neoprene sheets, of manufacturer's standard hardness and cross-ribbed or waffled pattern. Pad thickness shall be selected such that suitable deflection is provided i.e., the supported equipment provides a loading in the upper half of the manufacturer's loading range. Neoprene pads shall not be overloaded such that complete deflection is achieved.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PERFORMANCE OF ISOLATORS

- A. General: Comply with minimum static deflectors recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendation for selection and application of vibration materials and units.

3.3 APPLICATIONS

- A. General: Except as otherwise indicated, select vibration control products in accordance with ASHRAE Handbook, 2019 Applications Volume, Chapter 49 "Noise and Vibration Control," Table 47. Where more than one type of product is offered, selection is Installer's option.

3.4 INSTALLATION

- A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.
- B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

3.5 ADJUSTING AND CLEANING

- A. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

END OF SECTION

SECTION 23 05 53

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of mechanical identification work required by this section is indicated on Drawings and/or specified in other Division 23 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Plastic Pipe Markers.
 - 2. Engraved Plastic-Laminate Signs.
- C. Mechanical identification furnished as part of factory-fabricated equipment, is specified as part of equipment assembly in other Division 23 sections.
- D. Refer to other Division 23 sections for identification requirements at central-station mechanical control center; not work of this section.
- E. Refer to Division 26 sections for identification requirements of electrical work; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
 - 1. Allen Systems, Inc.

2. Brady (WHO) Co.; Signmark Div.
3. Industrial Safety Supply Co., Inc.
4. Seton Name Plate Corp.

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, and pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- C. Small Pipes: For external diameters less than 6 in. (including insulation if any), provide full-band pipe markers, extending 360° around pipe at each location, fastened by one of the following methods:
 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 2. Adhesive lap joint in pipe marker overlap.
 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 in. wide; full circle at both ends of pipe marker, tape lapped 1-1/2 in.
- D. Large Pipes: For external diameters of 6 in. and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 1. Laminated or bonded application of pipe marker to pipe (or insulation).
 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 in. wide; full circle at both ends of pipe marker, tape lapped 3 in.
 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- E. Lettering: Manufacturer's standard pre-printed nomenclature that best describes piping system in each instance, as selected by Engineer and Owner's Representative in cases of variance with name as shown or specified.
- F. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
 1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.4 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/8 in., except as otherwise indicated.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.5 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
 - 1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification that indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces that require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Near major equipment items and other points of origination and termination.
- C. Piping Identification
 - 1. Provide piping identification for the following:

System	Background Color	Text Color
Chilled Water Supply	Green	White

Chilled Water Return	Green	White
Heating Water Supply	Green	White
Heating Water Return	Green	White

3.3 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Air Handling Units.
 - 2. Fans.
- B. Lettering Size: Minimum 1 in. high lettering for name of unit.

3.4 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device, which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of mechanical insulation required by this section is indicated on Drawings and schedules, and by requirements of this section.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass.
- C. Refer to Section 23 31 13 "METAL DUCTWORK" for duct linings; not work of this section.
- D. Refer to Section 23 05 53 "MECHANICAL IDENTIFICATION" for installation of identification devices for piping, ductwork, and equipment; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Babcock & Wilcox; Insulating Products Div.

3. CertainTeed Corp.
4. Knauf Fiber Glass.
5. Johns Manville Products Corp.
6. Owens-Corning Fiberglass Corp.
7. Pittsburgh Corning Corp.

2.2 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated.
- B. Jackets for Piping Insulation: ASTM C 921 and ASTM C 1136, Type I (Vapor Barrier) for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installer's option.
 1. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations, ASTM D 1784.
- C. Staples, Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.
- D. Adhesives, Sealers and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
- E. Color:
 1. Chilled Water - Safety Blue
 2. Heating Water - Orange

2.3 PVC COLORED INSULATION JACKETING:

- A. PVC insulation jacketing to cover all new chilled water and all new heating water piping.
- B. Thickness: minimum 20 mil.
- C. Color:
 1. Chilled Water - Safety Blue
 2. Heating Water - Orange

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Thickness of insulation shall be as recommended by the manufacturer for the temperatures and pipe sizes involved, and in accordance with standards of T.I.M.A.

3.2 HVAC PIPING SYSTEM INSULATION

- A. Dual Temperature Piping (40° to 200°F (4.4° to 94°C)):
 - 1. Application Requirements: Insulate the following dual temperature HVAC piping systems:
 - a. HVAC hot/chilled water supply and return piping.
 - 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1-1/2 in. thick for pipe sizes up to and including 1-1/4 in., 2 in. thick for pipe sizes over 1-1/4 in.

3.3 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 in. wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 in. wide vapor barrier tape or band.
- I. Do NOT insulate over pipe hangers. If pipe hangers for piping to be insulated are not adequately sized for insulation to pass through the hanger, notify the General Contractor and Architect.

3.4 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.5 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION

SECTION 23 21 13.23

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of hydronic piping work is indicated on drawings and schedules, and requirements of this section.
- B. This section includes pipe, fittings, and valves for hydronic piping systems installed in the project as follows:
 - 1. Heating Water.
 - 2. Chilled Water.
 - 3. Miscellaneous Drain Lines.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hydronic piping products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with hydronic piping work similar to that required for project.
- C. Codes and Standards:
 - 1. ASME Compliance: Fabricate and install hydronic piping in accordance with ASME B31.9 "Building Services Piping".
 - 2. IMC Compliance: Fabricate and install hydronic piping in accordance with "International Mechanical Code."

1.3 SUBMITTALS

- A. Provide the following submittals in accordance with Division 01 and Section 23 00 10.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for hydronic piping materials and products.
- C. Shop Drawings: Submit scaled layout Drawings of hydronic piping and fittings including, but not necessarily limited to, pipe and tube sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between piping and proximate equipment.
- D. Submit certificates as listed below:
 - 1. Test Certificates of Approval for Piping Systems.
- E. Record Drawings: At project closeout, submit Record Drawings of installed hydronic piping and piping products, in accordance with requirements of Division 01.

1.4 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS - GENERAL

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements.
- B. Provide materials and products complying with ASME B31.9 Code for Building Services Piping where applicable, base pressure rating on hydronic piping systems maximum design pressures.
- C. Provide sizes and types as required to match piping and equipment connections; provide fittings of materials which match pipe materials used in hydronic piping systems.
- D. Where more than one type of material or product is indicated, selection is Installer's option.

2.2 BASIC PIPES AND PIPE FITTINGS

- A. Hydronic Piping:
 - 1. Pipe Size 2 in. and Smaller: ASTM A53 black steel pipe; Schedule 40; ASTM A126 Fittings Class 125 cast-iron with ANSI B16.4 threaded joints.
 - 2. Tube Size 3 in. and Smaller: ASTM B88 copper tube; Type L, hard-drawn temper; wrought-copper fittings, ANSI/ASME B16.27 with soldered joints, ANSI/ASTM B32, Grade 95TA.
 - 3. Pipe Size 2-1/2 in. and Larger: ASTM A53 black steel pipe; Schedule 40; wrought-steel butt welding standard weight fittings, ASTM A234 and ANSI/ASME B16.9 with welded joints, ANSI/ASME B16.25.
 - 4. Pipe Size 2-1/2 in. and Larger: Black steel pipe; Schedule 40, ASTM A53 grooved fittings with mechanical grooved couplings.
 - 5. Hydronic Drain Piping: Copper pipe; ASTM B306, DWV fittings; ANSI/ASME B16.3, cast bronze, or AWSI/ASME B16.29, wrought copper. Joints: ANSI/ASTM B32, solder, Grade 50B.

2.3 FLANGES, UNIONS AND COUPLINGS

- A. Pipe Size 2 in. and under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
- B. Pipe Size Over 2 in.: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; gaskets suitable for intended service – NO ASBESTOS GASKET MATERIAL ALLOWED.
- C. Grooved and Shouldered Pipe End Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction and expansion; "C"

shape composition sealing gasket; steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.

1. Acceptable Manufacturers:
 - a. Apollo Shurjoint
 - b. Gruvlok (Anvil International)
 - c. Tyco (Grinnell Mechanical Products)
 - d. Victaulic

- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, and water impervious isolation barrier.

2.4 BASIC VALVES

A. Ball Valves: For shutoff and throttling.

1. Ball valves 2 in. and less: MSS SP-72, rated for 200 psig minimum water pressure, full port, forged brass, bronze or stainless steel body, 316 or 304 stainless steel ball and stem, reinforced Teflon seats and seals, threaded or soldered connections. Throttling valves shall be provided with memory stops (for establishing any setpoint from 0-100% flow).
 - a. Acceptable Manufacturers and Models:
 - 1) Apollo 77-100 Series
 - 2) Jomar T-100-SS
 - 3) KITZ 68M
 - 4) Nibco T-585-70-66
 - 5) Victaulic Series 722
 - 6) Watts B-6080, B-6081
2. Ball valves 2-1/2 in. and greater: MSS SP-72, rated for 200 psig minimum water pressure, full port, cast iron, bronze or stainless steel body, 316 or 304 stainless steel ball and stem, reinforced Teflon seats and seals, flanged connections. Throttling valves shall be provided with memory stops (for establishing any setpoint from 0-100% flow).
 - a. Acceptable Manufacturers and Models:
 - 1) Apollo 6PLF
 - 2) Crane KF 953
 - 3) Jomar T-100-SS (NPT) or FL-CS-100-150 (FLANGED)
 - 4) KITZ 90
 - 5) Nibco T-585-70-66
 - 6) Victaulic Series 727
 - 7) Watts G 4000

B. Butterfly Valves: For shutoff and throttling.

1. Butterfly valves 2-1/2 in. and larger: MSS SP-67, rated for 200 psig minimum water pressure, full lug style with threaded connections (rated for dead end service), iron body, stainless steel stem, EPDM seat material, gear operator with wheel, for flanged connections. Throttling valves shall be provided with memory stops (for establishing any setpoint from 0-100% flow).
 - a. Acceptable Manufacturers and Models:
 - 1) Apollo LD141
 - 2) Crane 42
 - 3) Jomar 600/900
 - 4) KITZ 6123E, 6121E
 - 5) LD-2000-3 (Lever operated)
 - 6) LD-2000-5 (8" and above gear operated)

7) Milwaukee	ML Series
8) Stockham	LG-522
9) Victaulic	Vic-300 MasterSeal
10) Watts	BF-03

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which hydronic piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Prior to and during the installation of grooved piping systems, the grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and the installation of all grooved-end products. The manufacturer's representative shall periodically visit the jobsite to review and inspect installations. Contractor shall remove and replace any joints deemed improperly installed. All grooving tools and products shall be of the same manufacturer.

3.2 INSTALLATION OF HYDRONIC PIPING

- A. General: Install hydronic piping in accordance with the following requirements:
 1. Install eccentric reducers where pipe is reduced in size in direction of flow, with tops of both pipes and reducer flush.
 2. Install piping with 1/32 in. per ft. (1/4%) upward slope in direction of flow.
 3. Connect branch-feed piping to mains at horizontal centerline of mains; connect run-out piping to branches at horizontal centerline of branches.
 4. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
 5. Install dielectric connections wherever joining dissimilar metals.

3.3 INSTALLATION OF VALVES

- A. Provide ball, or butterfly valves for shutoff service as follows:
 1. On inlet and outlet of each mechanical equipment item.
 2. As drain valves on each mechanical equipment item located to completely drain equipment for service or repair.
- B. Install all Automatic Control Valves and all other control elements provided by Controls Contractor under a separate contract.

3.4 EQUIPMENT CONNECTIONS

- A. General: Connect hydronic piping system to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.

3.5 TESTING

- A. General: Furnish pumps, gauges, equipment, and personnel required, and test as necessary to demonstrate the integrity of the furnished installation.
- B. Pressure Piping: Hydrostatically test and make tight at 1-1/2 times the normal operating pressure and not less than 150 psig. Repair leaking joints and retest.
- C. Tests and Test Procedures shall be witnessed and approved by the Engineer or Owner's Representative..
- D. After completion and approval of testing, submit "Test Certificates of Approval" for heating water and chilled water piping systems stating that all test results are satisfactory. Certificates of Approval must be signed by Contractor.

3.6 CLEANING

- A. Cleaning, Flushing and Inspecting: Flush hydronic piping with potable water until the system can operate for eight (8) hours without partial build-up in strainers.

END OF SECTION

SECTION 23 21 13.24

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of hydronic specialties required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of hydronic specialties specified in this section include the following:
 - 1. Balance Valves.
 - 2. Vent Valves.
- C. Hydronic specialties furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.
- D. Refer to other Division 23 sections for insulation of hydronic specialties; not work of this section.

1.2 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Firms regularly engaged in manufacture of hydronic specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. **Hydronic Specialty Types:** Provide hydronic specialties of same type by same manufacturer.
- C. **Codes and Standards:**
 - 1. **ASME Compliance:** Manufacture and install hydronic specialties in accordance with ASME B31.9 "Building Services Piping".
 - 2. **UL and NEMA Compliance:** Provide electrical components of hydronic specialties that are listed and labeled by UL, and comply with NEMA standards.

1.3 SUBMITTALS

- A. **Product Data:** Submit manufacturer's technical product data and installation instructions for each type of hydronic specialty. Include pressure drop curve or chart for each type and size of hydronic specialty. Submit schedule indicating manufacturer's figure number, size, location, rated capacities, and features for each required hydronic specialty.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTIES

- A. **General:** Provide factory-fabricated hydronic specialties recommended by manufacturer for use in service indicated. Provide hydronic specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by

Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option, but more than one type cannot be used on project.

2.2 BALANCE VALVES

A. General: Provide balance valves as indicated, of one of the following types:

1. Threaded Ends 2 in. and Smaller: Multi-Turn Y Pattern Globe Style Balancing valve with shut-off function, draining kit, adjustments by a digital read-out Handwheel with a lock position feature, measuring of flow, differential pressure, and temperature, from two self-sealing measuring ports. Manufacturer shall provide flow measuring station if not integral within valve body via PT ports. Connection in NPT threads from 1/2" to 2". Made of dezincification resistant copper alloy. Handwheel shall have at least 400 different adjustments positions. Pressure class of 290 psi. Working temperature range -4°F to 248°F.
 - a. Acceptable Manufacturers / Models:
 - 1) IMI-TA/Victaulic Series 78K, Series 787
 - 2) Nibco T-1810
2. Soldered Ends 2 in. and Smaller: Multi-Turn Y Pattern Globe Style Balancing valve with shut-off function, draining kit, adjustments by a digital read-out Handwheel with a lock position feature, measuring of flow, differential pressure, and temperature, from two self-sealing measuring ports. Manufacturer shall provide flow measuring station if not integral within valve body via PT ports. Connection in NPT threads from 1/2" to 2". Made of dezincification resistant copper alloy. Handwheel shall have at least 400 different adjustments positions. Pressure class of 290 psi. Working temperature range -4°F to 248°F. IMI-TA/Victaulic Series 786 or approved equal.
 - a. Acceptable Manufacturers / Models:
 - 1) IMI-TA/Victaulic Series 786
 - 2) Nibco T-1810
3. Grooved Ends 2-1/2 in. and Larger: Multi-Turn Y Pattern Globe Style Balancing valve with shut-off function, adjustments by a digital read-out Handwheel with a lock position feature, measuring of flow, differential pressure, and temperature from two self-sealing measuring ports. Manufacturer shall provide flow measuring station if not integral within valve body via PT ports. Grooved connection from 2 1/2" to 12". Valve body made in ductile iron, bonnet restriction cone and spindle made of dezincification resistant brass alloy. Handwheel shall have 160-440 different adjustments positions depending on valve size. Pressure class ANSI 150#. Working temperature range -4°F to 248°F.
 - a. Acceptable Manufacturers / Models:
 - 1) IMI-TA/Victaulic Series 789
 - 2) Approved equal
4. Flanged Ends 2-1/2 in. and Larger: Multi-Turn Y Pattern Globe Style Balancing valve with shut-off function, adjustments by a digital read-out Handwheel with a lock position feature, measuring of flow, differential pressure, and temperature from two self-sealing measuring ports. Manufacturer shall provide flow measuring station if not integral within valve body via PT ports. Connection in ANSI flanges from 2 1/2" to 16". Valve body made in ductile iron, bonnet restriction cone and spindle made of dezincification resistant brass alloy. Handwheel shall have 160-440 different adjustments positions depending on valve size. Pressure class ANSI 150#. Working temperature range -4°F to 248°F. IMI-TA/Victaulic Series 788 or approved equal.
 - a. Acceptable Manufacturers / Models:
 - 1) IMI-TA/Victaulic Series 788
 - 2) Approved equal

2.3 VENT VALVES

- A. Manual Vent Valves: Provide manual vent valves designed to be operated manually with screwdriver or thumbscrew, 1/8 in. NPS connection.
- B. Manufacturer: Subject to compliance with requirements, provide vent valves of one of the following:
 - 1. Armstrong Machine Works.
 - 2. Bell & Gossett ITT; Fluid Handling Div.
 - 3. Hoffman Specialty ITT; Fluid Handling Div.
 - 4. Spirax Sarco.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which hydronic specialties are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF HYDRONIC SPECIALTIES

- A. Balance Valves: At Installer's option, install balance valves in lieu of terminal outlet valves and balance cocks. Install on each hydronic terminal and elsewhere as indicated. After hydronic system balancing has been completed, mark each balance valve with stripe of yellow lacquer across body and stop plate to permanently mark final balanced position.
- B. Vent Valves:
 - 1. Manual Vent Valves: Install manual vent valves on each hydronic terminal at highest point, and on each hydronic-piping drop in direction of flow for mains, branches, and run outs, and elsewhere as indicated.

END OF SECTION

SECTION 23 31 13

METAL DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.
- B. All duct dimensions shown on drawings are net inside clear dimensions.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with metal ductwork systems similar to that required for project.
- C. Codes and Standards:
 - 1. SMACNA Standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible", First Edition, 2005, for fabrication and installation of metal ductwork.
 - 2. ASHRAE Standards: Comply with ASHRAE Handbook latest edition, HVAC Systems and Equipment volume, Chapter 16 "Duct Construction", for fabrication and installation of metal ductwork.
 - 3. NFPA Compliance: Comply with latest editions of NFPA 90A "Installation of Air Conditioning and Ventilating Systems" and NFPA 90B "Installation of Warm Air Heating and Air Conditioning Systems".
- D. Field Reference Manual: Have available for reference at project field office, copy of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
- E. Flame/Smoke Ratings: Provide composite mechanical system (insulating material, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for metal ductwork materials and products.
- B. Shop Drawings: Submit scaled layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials and rigidity are not reduced.

- C. Record Drawings: At project closeout, submit record drawings of installed metal ductwork and ductwork products, in accordance with requirements of Division 01.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protection: Protect shop fabricated and factory fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials that are free from visual imperfections including pitting, seam marks, roller marks, and stains and discolorations, and other imperfections, including those that would impair painting.
- B. Sheet Metal: All interior ducts shall be constructed with G-60 or better galvanized steel (ASTM A 653/A 653M) LFQ, chem treat.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15° change of direction per section. Unless specifically detailed otherwise, use 45° laterals and 45° elbows for branch takeoff connections. Where 90° branches are indicated, provide conical type tees.
- C. Duct Liner:
 - 1. Fibrous glass, complying with Thermal Insulation Manufacturer's Association (TIMA) AHC-101; of thickness indicated with a minimum installed R-Value equal to 6.0 (1-1/2 in. thick minimum), with black-coated, fire-resistant airstream face, with EPA-registered antimicrobial agent.
 - 2. Flexible Unicellular
 - a. Ductwork Liner: ASTM C534 Type 1, Thickness 1-1/2 : with a minimum R-value equal to R-6.0.
 - 3. Manufacturers:
 - a. Certaineed "Toughgard".
 - b. Knauf Type "EM".
 - c. Johns Mansville "Permacote Linacoustic".
 - d. Owens-Corning "Aeroflex Plus".
 - e. Approved equal.

- D. Duct Liner Adhesive:
1. Comply with ASTM C 916 "Specifications for Adhesives for Duct Thermal Insulation." Application shall conform to Manufacturer's written recommendations for the apparent application.
 2. Adhesives shall be non-inflammable after curing.
 3. Manufacturers:
 - a. Benjamin-Foster.
 - b. Duro Dyne "FPG".
 - c. Kinco 15-137.
 - d. Miracle PF-91.
 - e. Manufacturer of duct liner used for this project.
- E. Duct Liner Fasteners:
1. Comply with SMACNA "Installation Standards for Rectangular Ducts using Flexible Liner", Articles S2.0 through S2.11.
 2. Comply with lining details as shown in the referenced SMACNA Section, Figures 2-22 and 2-23.
 3. Clinched-pin type fasteners shall be "Grip-Nail", or approved equal.
 4. Projecting pins in Type 3 or Type 4 applications shall be clipped off close enough to the retaining disc to provide proper anchoring and to prevent injury to personnel.
- F. Duct Sealant:
1. Duct sealer shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall seal out water, air, and moisture. Sealer shall be UL listed and conform to ASTM E 84.
 2. Comply with requirements of SMACNA Table 1-2.
 3. Manufacturers:
 - a. Benjamin-Foster
 - b. Ductmate - PROseal.
 - c. Duro Dyne S2.
 - d. Hardcast.
 - e. United Sheet Metal.
- G. Duct Cement:
1. Non-hardening, non-migrating mastic or liquid elastic sealant of type applicable for fabrication/installation detail as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
 2. Comply with requirements of SMACNA Table 1-2.
 3. Manufacturers:
 - a. Benjamin-Foster.
 - b. Duro Dyne S2.
 - c. Hardcast.
 - d. United Sheet Metal.
- H. Ductwork Support Materials:

1. General:
 - a. Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - b. Comply with applicable provisions of SMACNA 2005 Standards, Figures 4-1 through 4-8, and Tables 4-1 through 4-3.

2.3 FABRICATION

- A. Shop-fabricate ductwork in 4,8,10, or 12 ft. lengths, unless otherwise indicated or required to complete runs. Preassemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match mark sections for reassembly and coordinated installation.
- B. All duct dimensions shown on drawings are net inside clear dimensions.
- C. Shop-fabricate ductwork of gauges and reinforcement complying with SMACNA 2005 Standards as follows:
 1. Rectangular, Steel:
 - a. Tables 1-1 through 1-13.
 - b. Figures 1-2 through 1-18.
 - c. Fittings and Construction, Section II.
 2. Rectangular, aluminum: Pages 1-31 through 1-33.
 3. Round, Oval and Flexible Duct: Section III.
- D. Shop fabricate ductwork of gauges and reinforcement complying with ASHRAE Handbook, HVAC Systems and Equipment Volume, Chapter 16 "Duct Construction".
- E. Longitudinal Seams: Pittsburgh lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Snaplock is not acceptable.
- F. Ductmate or W.D.C.I. proprietary duct connection systems will be acceptable. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.
- G. Formed on flanges (T.D.C./T.D.F./T-25A/T-25B) will only be acceptable when submitted for approval prior to installation of any ductwork. Formed on flanges will be constructed as SMACNA T-25 flanges, whose limits are defined on Page 1.36 of the 2005 SMACNA Manual, First Edition. No other construction pertaining to form on flanges will be acceptable. Formed on flanges shall be acceptable for use on ductwork 42 in. wide or less, with 2 in. positive pressure static or less, and must include the use of corners, bolts and cleat.
- H. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center line radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30° for contracting tapers and 20° for expanding tapers.
- I. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division 23 Section "Ductwork Accessories" for accessory requirements.

- J. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners. Comply with previous paragraph 2.2.
- K. Pressure Classifications:
 - 1. Static pressure ratings for ductwork systems shall be as noted on the drawings, and/or shall conform to requirements of 2005 SMACNA Standards, Table 1-1.
 - 2. In no case shall the pressure rating of the duct be less than that indicated in Table 1-1 for the apparent duct velocity.
 - 3. Gauges of metal and reinforcing methods shall conform to SMACNA requirements as follows:
 - a. Rectangular Steel: Table 1-3 through 1-13.
 - b. Rectangular Aluminum: Tables 1-14 through 1-16.
 - c. Round, or Flat Oval, Steel: Table 3-2.
 - d. Round Aluminum: Table 3-3.

2.4 FACTORY-FABRICATED DUCTWORK

- A. At Contractor's option, factory-fabricated ductwork sections, fittings, etc., may be substituted for shop-made items.
- B. Factory-fabricated items shall comply in every respect with SMACNA requirements listed previously in this Section, or show proof from a recognized, approved independent laboratory, prior to bidding, that the proposed construction methods produce products that equal, or exceed, the SMACNA 2005 Standards.
- C. Comply with applicable provisions of International Mechanical Code and local amendments.
- D. Manufacturers: Subject to compliance with requirements, provide factory-fabricated ductwork and/or fittings of one of the following:
 - 1. Ductmate, Inc., Monongahela, PA.
 - 2. Semco Mfg., Inc.
 - 3. United Sheet Metal Div., United McGill, Inc.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF METAL DUCTWORK

- A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight (5% leakage for systems rated 3 in. and under; 1% for systems rated over 3 in.) and noiseless (no objectionable noise) systems, capable of performing

each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8 in. misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type that will hold ducts true to shape and to prevent buckling. Support vertical ducts at every floor. Seal all longitudinal and transverse duct joints and seams with non-hardening duct mastic.

- B. Inserts: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in work.
- C. Field Fabrication: Complete fabrication of work at project as necessary to match shop fabricated work and accommodates installation requirements.
- D. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- E. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.

3.3 INSTALLATION OF DUCT LINER

- A. General: Install duct liner in accordance with SMACNA HVAC Duct Construction Standards, pages 2-25 thru 2-29.
- B. All supply, return, and outside air ductwork serving air handlers shall be lined with 1-1/2 in. thick acoustical lining.

3.4 FIELD QUALITY CONTROL

- A. Leakage Tests: After installation of each duct system that is constructed for duct classes over 3 in. is completed, test for duct leakage. Repair leaks and repeat tests until total leakage is less than 1% of system design airflow.
- B. The testing shall be performed as follows:
 - 1. Perform testing in accordance with HVAC Air Duct Leakage Test Manual.
 - 2. Use a certified orifice tube for measuring the leakage.
 - 3. Define section of system to be tested and blank off.
 - 4. Determine the percentage of the system being tested.
 - 5. Using that percentage, determine the allowable leakage (CFM) for that section being tested.
 - 6. Pressurize to operating pressure and repair any significant or audible leaks.
 - 7. Re-pressurize and measure leakage.
 - 8. Repeat steps 6 and 7 until the leakage measured is less than the allowable defined in step 5.

3.5 EQUIPMENT CONNECTIONS

- A. General: Connect metal ductwork to equipment as indicated; provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.6 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- B. Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until time connections are to be completed.

END OF SECTION

SECTION 23 31 13.19

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.
- B. Types of ductwork accessories required for project include the following:
 - 1. Dampers.
 - a. Low-pressure manual dampers.
 - b. Control dampers.
 - 2. Turning vanes.
 - 3. Duct hardware.
 - 4. Duct access doors.
 - 5. Flexible connections.
- C. Refer to other Division 23 sections for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Codes and Standards:
 - 1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible," 2005 edition.
 - 2. Industry Standards: Comply with latest ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
 - 3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers."
 - 4. NFPA Compliance: Comply with applicable provisions of NFPA 90A latest edition "Installation of Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

- B. Shop Drawings: Submit manufacturer's assembly type Shop Drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

PART 2 - PRODUCTS

2.1 DAMPERS

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multi blade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards."
- B. Control Dampers: Control dampers shall be furnished by Building Automation Systems (BAS) contractor under a separate contract. This contractor shall install all dampers furnished by the BAS Contractor.
- C. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:
 - 1. Air Balance, Inc.
 - 2. Nailor
 - 3. American Warming & Ventilating, Inc.
 - 4. Louvers & Dampers, Inc.
 - 5. Penn Ventilator Co.
 - 6. Ruskin Mfg. Co.
 - 7. Pottorff

2.2 TURNING VANES

- A. Fabricated Turning Vanes: Provide fabricated turning vanes and vane runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards".
- B. Turning Vanes: Turning vanes shall be air-foil shaped double wall turning vanes fabricated from the same material as the duct. Tab spacing shall be SMACNA standard. Rail systems with non-standard tab spacings shall not be accepted. All tabs shall be used, do not skip tabs. Mounting rails shall have friction insert tabs that align the vanes automatically. Vanes shall be subjected to tensile loading and be capable of supporting 250 lbs when fastened per the manufacturer's instructions.
- C. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following:
 - 1. Aero Dyne Co.
 - 2. Anemostat Products Div.; Dynamics Corp. Of America
 - 3. Barber-Colman Co.
 - 4. Ductmate Industries, Inc.
 - 5. Duro Dyne Corp.
 - 6. Hart & Cooley Mfg. Co.

7. Register & Grille Mfg. Co., Inc.

2.3 DUCT HARDWARE

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
 1. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12 in. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
- B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:
 1. Ventfabrics, Inc.
 2. Young Regulator Co.

2.4 DUCT ACCESS DOORS

- A. General: Provide where indicated, duct access doors of size indicated.
- B. Construction: Construct of same or greater gauge as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12 in. high and smaller, 2 handle-type latches for larger doors.
- C. As an option, clamping type access doors may be installed.
- D. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:
 1. Air Balance Inc.
 2. Ductmate Industries, Inc.
 3. Duro Dyne Corp.
 4. Register & Grille Mfg. Co., Inc.
 5. Ruskin Mfg. Co.
 6. Ventfabrics, Inc.
 7. Zurn Industries, Inc; Air Systems Div.

2.5 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibrating equipment. Construct flexible connections of neoprene coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.
- B. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following:

1. American/Elgen Co.; Energy Div.
2. Ductmate Industries
3. Duro Dyne Corp.
4. Flexaust (The) Co.
5. Ventfabrics, Inc.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90° elbows in supply air systems, omit in return air and exhaust air.
- C. Install manual balancing dampers for branch ducts and individual runout ducts as close to the main duct as possible.
- D. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- E. **Install all Automatic Control Dampers and Fire/Smoke Dampers provided by Building Automation System Contractor under a separate contract.**
- F. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
 1. Label access doors in accordance with Division 23 Section "MECHANICAL IDENTIFICATION".

- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 EXTRA STOCK

- A. Furnish extra fusible links to Owner, one link for every 10 installed of each temperature range; obtain receipt.

END OF SECTION

SECTION 23 34 00

FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of fan work required by this section is indicated on Drawings and schedules, and by requirements of this section.
- B. Types of centrifugal fans required for project include the following:
 - 1. Centrifugal Fans.
 - 2. Utility Fans.
- C. Types of axial fans required for project include the following:
 - 1. Vaneaxial Fans.
- D. Refer to Section 23 05 12 - "MECHANICAL AND ELECTRICAL COORDINATION" for responsibility of electrical work. Electrical work required of Division 23 shall be done in compliance with requirements of Division 26 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of centrifugal and axial fans, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Codes and Standards:
 - 1. AMCA Compliance: Provide centrifugal fans bearing the AMCA Certified Ratings Seal. Sound rate centrifugal fans in accordance with AMCA 300 "Test Code for Sound Rating Air Moving Devices".
 - 2. AMCA Compliance: Provide axial fans bearing the AMCA Certified Ratings Seal.
 - 3. ASHRAE Compliance: Test and rate centrifugal and axial fans in accordance with ASHRAE 51 (AMCA 210) "Laboratory Methods of Testing Fans for Rating", latest edition.
 - 4. UL Compliance: Provide centrifugal and axial fan electrical components that have been listed and labeled by UL.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for fans, including specifications, capacity ratings, fan performance curves with operating point clearly indicated, gauges and finishes of materials, dimensions, weights, accessories furnished, and installation instructions.
- B. Shop Drawings: Submit assembly-type shop Drawings showing fan dimensions, required clearances, construction details, and field connection details.

- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to fan units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance instructions, including lubrication instructions, motor and drive replacement, and spare parts lists. Include this data, product data; shop Drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 01.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.
- B. Handle fans carefully to avoid damage to components, enclosures, and finish. Do not install-damaged components; replace and return damaged components to centrifugal fan manufacturer.
- C. Store fans in clean dry place and protect from weather and construction traffic.
- D. Comply with manufacturer's rigging and installation instructions for unloading fans, and moving them to final location.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS

- A. General: Provide centrifugal fans of sizes and arrangement as indicated, and of capacities and having accessories as scheduled.
- B. Fan Units: Provide factory-assembled and tested fan units consisting of housing, wheel, fan shaft, bearings, and side support structure. Clean, condition, and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.
- C. Housings: Provide curved scroll housings; lock seam construction for sizes 24 in. to 40 in., spot welded construction for sizes 44 in. to 60 in., and continuous weld construction for sizes 66 in. and larger. Provide horizontally split housings, bolted together for sizes 66 in. and larger. Provide spun inlet cones and duct connections.
- D. Wheels: Provide blades as indicated on schedule. Weld blades to wheel rim and hub plate. Key wheels to shafts. True and dynamically balance wheels after assembly.
- E. Shafts: Construct of AISI 1040 or 1045 solid hot-rolled steel, turned and polished.
- F. Bearings: Provide heavy-duty, grease-lubricated and re-greaseable, precision anti-friction ball or roller, self-aligning, pillow block type bearings selected for minimum average life (AFBMA L50) of 100,000 hours.

- G. Motors: Provide energy efficient motors in accordance with Division 23 Section "BASIC MECHANICAL REQUIREMENTS".
- H. Drive: Provide V-belt drive, selected for 1.4 service factor. Provide adjustable pitch sheave, selected for midpoint at design conditions.
- I. Manufacturer: Subject to compliance with requirements, provide centrifugal fans of one of the following:
 - 1. Greenheck
 - 2. Loren Cook Co

2.2 UTILITY FANS

- A. General: Provide utility fans of sizes and arrangement as indicated, and of capacities and having accessories as scheduled.
- B. Fan Units: Provide factory-assembled and tested fan units consisting of housing, wheel, fan shaft, bearings, and fan drive. Clean, condition and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.
- C. Housings: Construct of heavy-gauge steel with side sheets fastened to scroll sheets by means of deep lock seam. Provide round inlet collar, slip joint discharge duct connection. Construct housing to be convertible to 8 standard discharges. Provide adjustable motor supports.
- D. Wheels: Provide forward curved or backward inclined wheels as scheduled. Provide swaged hubs. Balance wheels statically and dynamically.
- E. Shafts: Construct of AISC 1040 ground and polished steel. Apply rust-preventive coating.
- F. Bearings: Provide self-aligning, grease-lubricated and re-greasable, pillow block type bearings, selected for minimum average life (AFBMA L50) of 200,000 hours.
- G. Motors: Provide open drip-proof energy efficient motors with ball or sleeve bearings. Provide split phase or capacitor start motors for fractional horsepower, with resilient base. Provide induction motors for integral horsepower, with rigid base.
- H. Drives: Provide V-belt drives for fractional horsepower motors selected for 1.2 service factor. Provide V-belt drives for integral horsepower motors selected for 1.4-service factor. Provide adjustable pitch sheave, selected for midpoint at design conditions or direct drive as scheduled.
- I. Accessories: Provide the following accessories as indicated and/or scheduled:
 - 1. Backdraft Dampers: Provide gravity-actuated dampers on fan discharge, counter-weighted, with interlocking aluminum blades with felt edges in steel frame.
 - 2. Weather Hoods: Provide protective weather hood with stamped vents over motor and drive compartment.

- J. Manufacturer: Subject to compliance with requirements, provide utility fans of one of the following:
 - 1. Greenheck.
 - 2. Loren Cook Co.

2.3 VANEAXIAL FANS

- A. General: Provide vaneaxial fans of size and arrangement as indicated, and of capacities and having accessories as scheduled.
- B. Housings: Provide minimum 14-gauge steel housing with integral inlet bell and diffuser sections. Provide outer frame for mounting, and slip-joint connections on inlet and outlet. Cover housing and frame with manufacturer's standard protective finish on both sides.
- C. Wheels: Axial flow type with airfoil shaped blades mounted on wheel plate. Provide dynamic balance for smooth operation. Provide solid steel shaft keyed to fan wheel.
- D. Bearings: Provide grease-lubricated bearings selected for minimum average life (AFBMA L50) of 200,000 hours at maximum cataloged operating conditions. Extend grease lines to outside of housing.
- E. Motors: Provide energy efficient motors in accordance with Division 23 Section "Basic Mechanical Requirements". Mount motors on adjustable motor base.
- F. Drives: Provide V-belt drives, selected for 1.4 service factor. Provide adjustable pitch sheave, selected for midpoint at design conditions.
- G. Accessories: Provide the following accessories as indicated and/or scheduled:
 - 1. Inlet Vanes: Provide adjustable inlet vanes having peripheral control linkage operated from outside air stream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation as scheduled.
 - 2. Inlet Screens: Provide heavy wire mesh inlet screens on free-inlet fans.
 - 3. Flanged Connections: Provide duct flanges on fan inlet and outlet.
- H. Manufacturer: Subject to compliance with requirements, provide vaneaxial fans of one of the following:
 - 1. Greenheck.
 - 2. Loren Cook Co.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FANS

- A. General: Install fans where indicated, in accordance with manufacturer's installation instructions, and with recognized industry practices, to ensure that fans comply with requirements and serve intended purposes.
- B. Access: Provide access and service space around and over fans as required, but in no case less than that recommended by manufacturer.
- C. Isolation: Isolate fans with vibration isolators; fasten in accordance with manufacturer's installation instructions.
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Ensure that rotation is in direction intended for proper performance. Do not proceed with fan start-up until wiring installation is acceptable to centrifugal fan Installer.
- E. Ductwork Connections: Refer to Division 23 "METAL DUCTWORK" sections. Provide flexible connections on inlet and outlet duct connections.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of fans, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected.

3.4 ADJUSTING AND CLEANING

- A. Start-up, test, and adjust fans in presence of manufacturer's authorized representative.

3.5 FIRST YEAR MAINTENANCE MATERIALS

- A. Materials: Furnish to Owner, with receipt, one extra set of belts for each belt driven fan for each air handling unit.
- B. Provide one (1) extra motor for each different motor size provided with the fans. Obtain receipt from Owner that the motors have been received.

END OF SECTION

SECTION 23 73 13

AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of air handling unit work is indicated on Drawings and schedules, and by requirements of this section.
- B. Types of packaged air handling units specified in this section include the following:
 - 1. Indoor draw-through with VAV control.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of packaged air handling units with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Codes and Standards:
 - 1. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards 210 and 500.
 - 2. ARI Compliance: Test and rate air handling units in accordance with ARI 430 "Standard for Central Station Air Handling Units", display certification symbol on units of certified models.
 - 3. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration", latest edition.
 - 4. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A Installation of Air Conditioning and Ventilating Systems", latest edition.
 - 5. UL and NEMA Compliance: Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA Standards.
 - 6. NEC Compliance: Comply with National Electrical Code (NFPA 70) latest edition as applicable to installation and electrical connections of ancillary electrical components of air handling units.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, gauges and finishes of materials, and installation instructions.
- B. Shop Drawings: Submit assembly-type shop Drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.

- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air handling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data; shop Drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 01.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air-handling units with factory-installed shipping skids and lifting lugs; pack components in factory fabricated protective containers.
- B. Handle air-handling units carefully to avoid damage to components, enclosures, and finish. Do not install-damaged components; replace and return damaged components to air handling unit manufacturer.
- C. Store air-handling units in clean dry place and protect from weather and construction traffic.
- D. Comply with Manufacturer's rigging and installation instructions for unloading air handling units, and moving them to final location.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide air handling units of one of the following:
 - 1. Aeon
 - 2. JCI / York
 - 3. Temtrol
 - 4. Trane
 - 5. Daikin
 - 6. Miller Picking
 - 7. ClimateCraft

2.2 AIR HANDLING UNITS

- A. General: Provide factory-fabricated and factory-tested air handling units as indicated, of sizes and capacities as scheduled, and as specified herein.
- B. Casings: Construct casings of galvanized steel, maximum L/240 deflection, designed to withstand specific operating pressures. Provide casing panels and/or access doors that are easily and quickly removable for inspection and access to internal parts.

1. Provide single zone units consisting of fan section, coil section, adjustable fan motor mounting, and drain pan.
 2. Provide reinforced points of support for either setting or hanging units.
 3. Provide stainless steel insulated drain pan, located under cooling coil section extensive enough to catch condensate leaving the coil at highest catalogued face velocity. Provide at least one drain connection at low point in drain pan. Drain connections shall be located so as to provide and ensure positive condensate drainage – no standing water.
 4. Cover casing and frame with manufacturer's standard protective finish on both sides.
- C. Coils: Provide heating and cooling coil(s) of scheduled capacity, mounted in unit in manner permitting removal.
1. Construct coils with copper tubing primary surface and aluminum secondary surface bonded to tubes by method approved by specified manufacturer. Provide chilled water and heating coils with threaded connections. Provide chilled water coils with drain and vent connections. Pitch coils in unit casing for drainage.
- D. Coil Sections: Provide common casing for heating and cooling coil(s) as required. Design internal structure of coil section to allow for removal of coil(s), and provide suitable baffles to assure no air bypass around coil(s). Provide condensate pans and drain connections to cooling coil sections of sufficient size to contain and remove coil condensate. Insulate coil section casings and drain pans as specified in "Insulation" paragraph.
- E. Fan Array:
1. The multiple fan array systems shall include multiple, direct driven, arrangement plenum fans constructed per AMCA requirements for the duty specified class III as required. Class 1 fans are not acceptable. Fans shall be rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Static Pressure. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor cube or cell shall include a minimum 10 gauge, G 90 Galvanized steel intake wall, .100 aluminum spun fan inlet funnel, and an 10 gauge G 90 Galvanized steel motor support plate rain and structure. All motors shall be standard floor mounted type TEAO selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motor shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2 Motors shall approved for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Total motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedule(s). Steel cased motors and/or ODP motors are not acceptable. All motors shall include permanently sealed (L10-400,000 hf) bearings and AEGIS™ shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft currents. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, exceeding category BV-5, to meet or exceed an equivalent Grade G.55, producing a maximum rotational imbalance of .03" per second peak, filter in (.55mm per second peak, filter in). Fan and motor assemblies submitted for approval incorporating larger than 22" wheel size and 215 T frames size motors shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement with a maximum rotational imbalance of .03" per second peak filter in (.55 mm per second peak, filter in). Copies of the certified balancing reports shall be provided with the unit O&M manuals at the time of

shipment. Submittals that do not include a statement of compliance with this requirement will be returned to the Contractor without review.

2. The fan array shall consist of multiple fan and motor "cubes" or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. In order to assure uniform velocity profile in the AHU cross section, the fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing that must be such that the submitted array dimensions fill a minimum of 90% of the cross sectional area of the AHU air way tunnel. There shall be no blank off plates or "spacers" between adjacent fan columns or rows to position the fans across the air way tunnel. The array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit to equal the specified cooling coil and/or filter bank face velocity by +/- 10% when measured at a point 36" from the intake side of the fan array intake plenum wall, and at a distance of 72" from the discharge side of the fan array intake plenum wall. Submittals for units shall submit CFD modeling of the air flow profile for approval that indicates uniform velocity and flow across all internal components without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.
 3. Each individual cube or cell in the multiple fan arrays shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled. Submitted AHU performance that does not indicate allowance for system effects for the back flow prevention device(s) and the system effect for the fan and motor enclosure in which each fan is mounted, will be returned to the Contractor disapproved and will need to be resubmitted. Back Draft Damper performance data that is per AMCA ducted inlet and discharge arrangements will not be accepted. Damper data must be for the specific purpose of preventing back flow in any disabled fan cube and that is mounted directly at the inlet of each fan. Motorized dampers for this purpose are not acceptable. Submitted fan performance data which only reflect published performance for individual fans in AMCA arrangement "A" free inlet and discharge will not be accepted. AHU Manufacturers that do not manufacture the fans being submitted on must provide certified performance data for fans as installed in the AHU unit with Back Draft damper effects included. At the sole discretion of the engineer, such performance testing may be witnessed by the Engineer and/or the Owner's representative.
 4. Each fan motor shall be individually wired to a control panel containing a single VFD as the primary VFD. Each VFD shall be sized for the total connected HP for all motors contained in the Array. The total fan motor horsepower shall not exceed the scheduled horsepower. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards and local code requirements.
- F. Filter Boxes: Provide filter boxes with either hinged access doors or quickly removable panels, at each end. Provide racks to receive filters in flat type pattern.
- G. Insulate casing sections with 1-1/2 in. thick, 3 lbs. per cu.ft. Density, neoprene coated, glass fiber insulation, "K" value at 75°F maximum 0.26 Btu/in./sq.ft./°F/hr, applied to internal surfaces with adhesive and weld pins. Coat exposed edges of insulation with adhesive. Insulation and adhesive shall conform to NFPA 90A.
- H. Provide insulation with fire-retarding characteristics, complying with NFPA 90A. Insulate drain pans as required to prevent condensate formation on unit exterior at ambient conditions to be encountered.
- I. UV-C Lights

1. Install UV-C lights within cooling coil section. The UV-C light system shall provide minimum of 20 Watts per square foot of coil coverage area and shall be complete with toggle switch, UV-C hour meter, warning signage, and 1 year lamp warranty. The UV-C lights shall be controlled by the BAS so that they can be enabled/disabled via BAS control.
 2. Provide service access door as required to access UV-C lamps for service and replacement.
 3. Provide appropriate warning signage on outside of AHU access door to protect Service Personnel.
- J. Air Filters: Provide 4" thick MERV 14 Air Filters.
- K. Air Volume Control:
1. Provide variable speed (frequency) drive as specified in Section 23 89 65.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF AIR HANDLING UNITS

- A. General: Install air handling units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
- B. Coordination: Coordinate with other work, including ductwork, floor construction, roof decking, and piping, as necessary to interface installation of air handling units with other work.
- C. Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.
- D. Support: Install floor mounted air-handling units on 4 in. high reinforced concrete pad, 4 in. larger on each side than unit base.
- E. Mounting: Mount air-handling units with internal vibration isolators on neoprene pad under base rails, in accordance with manufacturer's instructions.
- F. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- G. Piping Connections: Refer to Division 23 HVAC sections. Provide piping, valves, accessories, gauges, supports, and flexible connectors as indicated.

- H. Duct Connections: Refer to Division 23 Air Distribution sections. Provide ductwork, accessories, and flexible connections as indicated.
- I. Filters: Install filters prior to operation of any air handling units during construction. Maintain filters during construction to prevent units from becoming dirty. Do not operate units at any time without filters installed. Install complete new set of filters for each unit at the completion of construction.
- J. Grounding: Provide positive equipment ground for air handling unit components.

3.3 FIELD QUALITY CONTROL

- A. Testing: Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.

3.4 FIRST YEAR MAINTENANCE MATERIALS

- A. Provide one complete extra set of filters for each air-handling unit for first year maintenance. Obtain receipt from Owner that new filters have been received.
- B. Provide one extra set of belts for each belt driven air-handling unit, obtain receipt from Owner that belts have been received.

3.5 ATTIC STOCK

- A. Provide two (2) extra motors for each different motor size provided with the air handling units. Obtain receipt from Owner that the motors have been received.

END OF SECTION

SECTION 23 89 65

MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Manufacturer's Data: Submit manufacturer's data and installation instructions on motor controllers.

1.2 QUALITY ASSURANCE

- A. Comply with applicable requirements of NEC as applicable to installation, and construction of motor controllers.
- B. Comply with applicable requirements of NFPA 70E, "Electrical Safety Requirements for Employee Workplaces," latest edition.
- C. Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide controllers and components that are UL-listed and labeled.
- D. Comply with applicable requirements of NEMA Standards ICS 2, "Industrial Control Devices, Controllers and Assemblies", and Pub. No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)", pertaining to motor controllers and enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide motor controllers of one of the following (for each type and rating of motor controller):
 - 1. Allen-Bradley Co.
 - 2. Cerus Industrial.
 - 3. Cutler Hammer Products, Eaton Corp.
 - 4. General Electric Co.
 - 5. Square D Co.
 - 6. Danfoss-Graham.
 - 7. Reliance.
- B. Manufacturers: Subject to compliance with requirements, provide variable speed (frequency) drives of one of the following:
 - 1. ABB.
 - 2. Yaskawa.

2.2 MOTOR CONTROLLERS

- A. Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published information, and as required for a complete installation.
- B. Magnetic Starter, Across-The-Line:
1. Motor starters shall be across-the-line magnetic type rated in accordance with NEMA Standards, sizes and horsepower ratings as required for the motor controlled. Starters shall be mounted in general-purpose enclosures unless otherwise indicated on plans.
 2. Across-the-line magnetic starters through NEMA size seven shall be equipped with double break silver alloy contacts. Single break contacts shall be supplied on size eight starters. All contacts shall be replaceable without removing power wiring or removing starter from panel. The starter shall have straight-through wiring.
 3. Coils shall be of molded construction through NEMA size seven. Coils on size eight starters shall be form wound, taped, varnished and baked. All coils shall be replaceable from the front without removing the starter from the panel.
 4. Overload relays shall be the melting alloy type with a replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. The starter shall be inoperative if the thermal unit is removed. Provide overload heaters to protect the motor to be controlled.
 5. Provide one normally-open auxiliary contact and one normally-closed auxiliary contact in each NEMA size 0 through size 7 starters.
 6. Magnetic starters with "Hand-Off-Auto" selector switch and Form C contact, as manufactured by Square D, or acceptable substitute, three-pole, three-phase of NEMA size applicable with three melting alloy overload relays and three-position H-O-A switch in cover of general purpose enclosure.
 7. Provide starters of the proper NEMA size to control each motor. Do not provide starters smaller than NEMA size 0.
 8. Provide starters with low voltage transformers.
- C. Variable Speed (Frequency) Drives:
1. Each variable speed drive shall convert 3 phase, 60-hertz utility power to variable voltage and frequency, 3 phase, AC power for stepless motor control from 10% to 110% of base speed. The variable speed drive shall be a variable voltage or current source type with a six-step output utilizing power and semiconductors. The variable speed drive, together with all options and modifications, shall install within a standard NEMA I enclosure suitable for continuous operation at a maximum ambient temperature of 40°C. All high voltage components within the enclosure shall be isolated with steel covers. Circuits shall provide DV/DT and DI/DT protection for semi-conductors. Protective circuits shall cause instantaneous trip should any of the following faults occur:
 - a. 110% of controller maximum sine wave current rating is exceeded.
 - b. Output phase-to-phase short circuit condition.
 - c. High input line voltage.
 - d. Low input line voltage.
 - e. Loss of input phase.

- f. External Fault: This protective circuit shall permit, by means of the terminal strip, wiring of remote normally closed safety contacts such as high static, fire stat, etc., to shut down the device.
2. The following adjustments shall be available to the controllers:
 - a. Maximum frequency (60 to 80 Hz).
 - b. Minimum frequency (6 to 35 Hz).
 - c. Acceleration (2 to 20 seconds).
 - d. Deceleration (2 to 20 seconds).
 - e. Volts/Hertz ratio.
 - f. Voltage offset or boost.
 - g. Current limit (50% to 110% sine wave current rating).
 3. The variable speed drive shall be furnished with door mounted operator controls consisting of auto/manual switch, start/stop (reset) switch and manual speed control. In automatic mode, the controller shall follow an external signal and respond to remote start/stop contact wired to terminal strip. While in the auto mode, the controller shall automatically restart after the power outage.
 4. Input disconnect shall provide a positive disconnect between the controller and all phases of the incoming AC line. This disconnect shall be designed to mount inside the controller enclosure and include a mounting bracket and through-the-door interlocking handle with provisions for pad locking. The basic switch shall be magnet only molded case breaker.
 5. Provide electronic bypass drive package where indicated. All drive/bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508A label. Bypasses manufactured by anyone other than the drive manufacturer, are not acceptable.
 - a. The drive and bypass package shall be a complete factory wired and tested bypass system consisting of a padlockable disconnect device, drive output contactor, bypass contactor, and drive input fuses.
 - b. The drive and bypass package shall have a UL listed short circuit current rating of 100 kA, for 240 VAC and 480 VAC systems, and this rating shall be indicated on the rating label.
 - c. The bypass control shall be powered by a three-phase switch mode power supply with a voltage tolerance of +30%, -35%. Single-phase power supplies and control power transformers (CPT) are not acceptable.
 - d. All bypass packages shall utilize a dedicated LCD bypass control panel (keypad) user interface. The bypass control panel must be a separate display from the drive control panel.
 - 1) The bypass shall include a two-line, 20-character LCD display. The display shall allow the user to access parameters and view:
 - (a) All three phases of the bypass input voltage, current (Amps) and power (kW)
 - (b) Bypass faults, warnings, and fault logs
 - (c) Bypass operating time and energy consumption (resettable)
 - 2) The bypass control panel shall include the following controls:
 - (a) Four navigation keys (Up, Down, Enter, Escape)
 - (b) Bypass Hand-Off-Auto, Drive mode / Bypass mode selectors, Bypass fault reset
 - 3) The following indicating lights (LED PTT type) or control panel display indications shall be provided.
 - (a) Drive mode selected, Bypass mode selected
 - (b) Drive running, Bypass running
 - (c) Drive fault, Bypass fault

- 4) Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch, smoke alarm, vibration trip, and overpressure.
- e. All Bypasses shall have the following hardware features/characteristics as standard:
- 1) Six (6) digital inputs and five (5) Form-C relay outputs. The digital inputs shall be capable of accepting both 24 VDC and 24 VAC. The bypass control board shall include an auxiliary power supply rated 24 VDC, 250 mA.
 - 2) Drive isolation fuses shall be provided. Bypass designs which have no such fuses, or that only incorporate fuses common to both the drive and the bypass are not acceptable. Third contactor "isolation contactors" and service switches are not an acceptable alternative to drive isolation fuses.
 - 3) The bypass shall be able to detect a single-phase input power condition before the bypass contactor closes or while running the motor in bypass, by monitoring all three phases of input voltage. Relying on a high current trip if the motor is single-phased is not acceptable.
 - 4) The bypass shall be able to detect a single-phase input power condition before the bypass contactor closes or while running the motor in bypass, by monitoring all three phases of input voltage. Relying on a high current trip if the motor is single-phased is not acceptable.
- f. All bypasses shall have the following software features as standard:
- 1) Programmable loss-of-load (broken belt / coupling) indication shall be functional in drive and bypass mode.
 - 2) The bypass shall also support run permissive and start interlock control functionality, including start delay, as previously specified in the drive section.
 - 3) The bypass control shall monitor the status of the drive and bypass contactors and indicate when there is a welded contactor contact or open contactor coil.
 - 4) The bypass shall include a selection for either manual or automatic transfer to bypass. The automatic transfer mode shall allow the user to select the specific drive fault types that result in an automatic transfer to bypass. The automatic transfer mode shall not allow a transfer to bypass on motor related faults. Automatic transfer schemes that do not differentiate between fault types, are not acceptable.
 - 5) The bypass shall include the ability to select the operating mode of the system (Drive/Bypass) from either the bypass control panel or digital input.
 - 6) The bypass shall include the ability to know the phase sequence and provide a phase sequence fault to indicate if the bypass and drive would run the motor in the opposite direction, this feature shall be enabled by default.
 - 7) The bypass shall include a supervisory control mode that monitors the value of the drive's analog input (feedback). This feedback value is used to control the bypass contactor on/off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps.
 - 8) Selectable Class 10, 20, or 30 electronic motor overload protection shall be included in both drive and bypass mode.
 - 9) The drive and bypass shall be designed to operate as an integrated system when in Override mode. Whether operating in drive or bypass mode, the low priority safeties will be ignored. There shall be four selectable Override modes:
 - (a) Bypass only, with two smoke control modes:
 - (1) Fixed pre-configuration of digital inputs.
 - (2) Configurable high/low priority safeties and faults, to allow configuration to meet needs of local Authority Having Jurisdiction.
 - (b) Drive only

- (c) Drive then transfer to bypass, in the event of a drive fault
- (d) Force to Stop
- 10) Before the bypass circuit can be tested in commissioning, the drive must start the motor to check for shorts and ground faults.
- g. Network communications - the bypass shall include BACnet MS/TP, Modbus, and Johnson Controls N2 as standard. The bypass BACnet implementation shall be BTL Listed to Revision 14 or later. Optional communication cards for BACnet/IP, LonWorks, Profibus, Profinet, Ethernet/IP, Modbus TCP, and DeviceNet shall be available.
 - 1) The bypass relay output status, digital input status, warning and fault information can be monitored over the network. Status information shall be monitored, including; operating mode (drive vs bypass), current drawn in bypass mode, broken belt, and phase-to-phase voltage. The bypass start/stop command, force to bypass command, and relay outputs shall be capable of being controlled over the network.
- 6. Motor overload shall contain a thermal overload relay designed to protect one AC motor operated on variable speed drive output from extended overload operation.
- 7. The variable speed drive shall follow in manual mode a set point frequency from a speed potentiometer. In automatic mode, the variable speed drive shall receive and follow a DC voltage signal from the microprocessor controller for full range operation.
- 8. Provide plug-in tester to provide a quick means for monitoring the different signals within the variable speed drive for startup and troubleshooting.

PART 3 - EXECUTION

3.1 COORDINATION WITH DIVISION 26

- A. Portions of the work will be provided under Division 26. Refer to Section 23 05 12 for coordination of the work with Division 26.

3.2 EXAMINATION

- A. Examine areas and conditions under which motor controllers are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.3 INSTALLATION OF MOTOR CONTROLLERS

- A. Install motor controllers for each motor, in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL and NEMA standards, to insure that products fulfill requirements.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

3.4 FIELD QUALITY CONTROL

- A. Prior to energization of motor controller equipment, check with ground resistance tester, phase-to-phase and phase-to-ground insulation resistance levels to insure requirements are fulfilled.
- B. Prior to energization, check circuitry for electrical continuity, and for short-circuits.
- C. Ensure that direction of rotation of each motor fulfills requirements.
- D. Ensure that motor overloads are properly sized and installed.

3.5 GROUNDING

- A. Provide equipment-grounding connections for motor controller equipment as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.6 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms, where necessary, for free mechanical movement.

3.7 DEMONSTRATION

- A. Upon completion of installation of motor controller equipment and electrical circuitry, energize controller circuitry and demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

3.8 ATTIC STOCK

- A. Provide one (1) extra Variable Speed (Frequency) drive for each different size drive with bypass that is provided for air moving equipment. Obtain receipt from Owner that the Variable Speed (Frequency) Drives have been received.

END OF SECTION

SECTION 26 05 10

GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all labor, materials, supervision, tools, services, equipment and incidentals necessary for complete and operational systems as specified under this division and as shown on the Contract Drawings.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Division.

1.2 DRAWINGS AND SPECIFICATIONS

- A. Prior to submitting a bid:
 - 1. Examine the Drawings.
 - 2. Read the Specifications and other Contract Documents, including Addenda and referenced material.
 - 3. Visit the site of the work, in accordance with directions from Purchasing Department.
 - 4. Become informed prior to bidding as to existing conditions and limitations of the project.
- B. Bring exceptions and inconsistencies in Drawings, specifications, addenda, referenced material, other Contract Documents and site conditions to the attention of the Purchasing Department in writing during the question period of the County bidding process; otherwise be responsible for changes and additions that become necessary during construction.
- C. Interpretation or correction of the Contract Documents will be made by Addendum and official responses to submitted questions and will be posted on the Tarrant County website.
- D. Location of material, equipment, devices and appliances shown in the Contract Drawings are approximate and are subject to such revisions as may be necessary or desirable at the time the work is installed. Install the work in relation to existing conditions and be responsible for the correctness of the work with reference to finish elevations and surrounding conditions.
- E. The Contract Documents show the general arrangements of the work. After contract award, should project conditions require any rearrangement, or if equipment or accessories can be installed to better advantage in a different manner, the Contractor may, before proceeding with the work, prepare and submit five copies of shop drawings of the proposed rearrangement for the Engineer's review.
- F. If the Contractor proposes to install equipment requiring space conditions other than those shown, he shall assume responsibility for the rearrangement of the space and shall have the Engineer review the change before proceeding with the work. The request for such changes shall be accompanied by shop drawings of the space affected.

- G. The accompanying Drawings do not indicate the existing electrical installations other than to identify modifications and extensions thereto. Visit the site in accordance with directions from Purchasing Department and ascertain the conditions to be met and the work to be accomplished in removing and modifying the existing work, and installing the new work. Failure to comply with this shall not constitute grounds for any additional payment in connection with removing or modifying any part of the existing installations and/or installing any new or temporary work under this Division.

1.3 CODES AND STANDARDS

- A. Execute the work in accordance with local, state and national codes, ordinances and regulations having jurisdiction or authority over the work. Make any and all adjustments required by these agencies without further cost to the Owner. In addition, conform to the applicable provisions and recommendations of the following standards:
 - 1. National Electrical Manufacturer Association (NEMA)
 - 2. American Society for Testing and Materials (ASTM)
 - 3. National Fire Protection Association (NFPA)
 - 4. National Electrical Safety Code (NESC)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. National Electrical Code (NEC)
 - 7. Underwriters' Laboratories (UL)
 - 8. American National Standards Institute (ANSI)
 - 9. International Building Code (IBC)
 - 10. Occupational Safety and Health Administration (OSHA)
 - 11. Americans with Disabilities Act (ADA)
 - 12. Applicable utility companies
 - 13. Texas Accessibility Standards (TAS)
 - 14. International Energy Conservation Code (IECC)
- B. Execute the work in accordance with the most current codes and standards in effect at the time of bidding.
- C. In the event standards and codes conflict with each other, the most stringent shall apply.
- D. Conform to National Electrical Code rules. Provide material and equipment, which is approved by Underwriter's Laboratories, bears UL label and is acceptable to Factory Mutual.
- E. It is specifically understood, however, that in those instances where capacities, sizes, etc., of electrical equipment, devices or material as designated in these Specifications or on the Drawings are in excess of the minimum requirements of the National Electrical Code, such designated capacities shall prevail.

PART 2 - PRODUCTS

2.1 SHOP DRAWINGS AND SUBMITTALS

- A. Submit Shop Drawings for all material furnished under this division of the work. Refer to the General Requirements for additional requirements. In addition to the quantity of Shop Drawing copies required by the General Requirements, furnish one additional copy for the Electrical Engineer's file. No material shall be fabricated, delivered to the jobsite, or installed which the Engineer through Shop Drawing submittals has not approved.
- B. The submittals shall include sufficient descriptive material, such as catalog cuts, diagrams, and other data published by the manufacturer, as well as evidence of compliance with safety and performance standards, to demonstrate conformance to the specification requirements; catalog numbers alone will not be acceptable. The data shall include the name and address of the nearest service and maintenance organization that regularly stocks repair parts.
- C. Deliver Shop Drawings to the Engineer in sufficient time to avoid delay of the project. Group Division 26 submittals as identified below, submit sections not included in these groupings separately. The Electrical Contractor shall acknowledge receipt of all Division 23 mechanical equipment submittals and confirm the overcurrent protection requirements of the project specific HVAC equipment has been coordinated with the distribution equipment prior to submitting for approval. All proposed changes to the overcurrent protection devices shall be clearly identified in the distribution equipment submittal.
 - 1. Distribution Equipment – Low Voltage
 - a. Section 26 22 13 - DRY TYPE TRANSFORMERS
 - b. Section 26 24 16 - PANELBOARDS
 - c. Section 26 28 16 - OVERCURRENT PROTECTIVE DEVICES
 - d. Section 26 28 17 - DISCONNECT SWITCHES
 - e. Section 26 29 13 - MOTORS, MOTOR STARTERS AND CONTROLS
- D. Submit samples for approval when requested by the Engineer.
- E. Before submitting Shop Drawings for review, examine them and verify that they correctly represent the material or equipment intended for this project. The Contractor's review of Shop Drawings is not intended to take the place of the review of the Engineer, and Shop Drawings which have not been reviewed by the Engineer shall not be used in fabricating or installing any work.
- F. List deviations and exceptions from the specified equipment in writing. Failure to do so will be cause for rejection of submittals. Contractor agrees that if deviations, discrepancies, or conflicts between Shop Drawing submittals and the Contract Documents are discovered either prior to or after Shop Drawing submittals are reviewed by the Engineer, the Contract Documents shall control and shall be followed, unless deviations have been specifically approved by the Engineer and Owner.
- G. The review of Shop Drawings or catalog data by the Engineer shall not relieve the Contractor from responsibility for deviations from plans and specifications unless the contractor has, in writing, specifically called attention to such deviations at the time of submission and has obtained the permission of the Engineer thereon; nor shall it relieve the contractor from responsibility for error of any kind in Shop Drawings. When the Contractor does call such deviations to the attention of the Engineer, they shall state in their letter

whether or not such deviations involve any extra cost. If this is not mentioned, it will be assumed that no extra cost is involved for making the change.

- H. Contractor agrees that Shop Drawing submittals reviewed by the Engineer are not change orders; that the purpose of Shop Drawing submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that the contractor demonstrates their understanding by indicating which equipment and material they intends to furnish and install and by detailing the fabrication and installation methods they intends to use.

2.2 STANDARDS FOR MATERIALS

- A. It is the intention of these specifications to indicate a standard of quality for all materials incorporated in this work. Manufacturer's names and catalog numbers are used to designate the item of equipment or material as a means of establishing grade and quality. Where several manufacturers are named, only the named manufacturer's products will be considered and the Contractor's bid shall be based on their product. Substitutions may be submitted for approval during the bidding process.
- B. Where the phrase 'or approved equivalent' or 'or equivalent' or 'equivalent to' or 'accepted substitute' is used in these specifications, the names or name mentioned are to be used as a basis of quality. Other manufacturers will be considered if the quality of the proposed material is equivalent to that of materials named, in the opinion of the Engineer.
- C. Basis of quality shall include material, workmanship, weight, finishes, and gauges of material, appearances, capacity and performance. Manufacturer's representation as to availability of equipment, replacement parts and service personnel in the area will be a factor in consideration of submittals.
- D. All materials shall be fully warranted.
- E. Furnish standard products and manufacturers regularly engaged in production of such equipment.
- F. Furnish manufacturer's latest standard design.
- G. All equipment shall conform with applicable IEEE, UL, ANSI and/or NEMA Standards.
- H. Obtain manufacturer's recommendations and instructions for all installed equipment including installation instructions, preparation cleaning, tests and preservice checks, and then ensure all have been performed prior to completion of work.

2.3 SUBSTITUTIONS

- A. The Engineer prior to installation shall approve substitutions of equipment. Substitution of equipment shall be in accordance with Division 01 of the specifications.
- B. Requests for substitutions of equipment, materials and apparatus listed in Division 26 Sections must be submitted in writing as a question during the prescribed timeframe for submitting questions. Refer to the instructions for bidders for timeframe. Such requests must be accompanied by complete data to permit proper evaluation.

- C. When alternate or substitute materials and equipment are used, the Contractor shall be responsible for space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, and other apparatus and trades that may be affected by their use.
- D. Contractor shall bear all additional costs resulting from the use of substituted materials. Such changes shall be at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate and direct the work under this division of the specifications with the work under other divisions of the specifications. Examine the Contract Documents and report any discrepancies between divisions of the work to the Engineer and obtain written instructions for changes necessary in the work.
- B. Before installation, make proper provisions to avoid interferences with the work under other divisions of the specifications. Changes required in the work of the Contractor caused by their neglect to do so shall be made by them at their at his own expense.
- C. Harmonize the work under this division with the work under other divisions of the specifications such that it may be installed in the most direct and workmanlike manner without hindering, or conflicting with the work under other divisions of the specifications. Piping interferences shall be handled by giving precedence to pipelines that require a stated grade for proper operation.

3.2 PERMITS AND FEES

- A. Secure and pay for all necessary permits, licenses and inspections required by law for the completion of the Work. Secure and pay for all certificates of approval that are required and deliver them to the Engineer before final acceptance of the Work.

3.3 QUALITY ASSURANCE

- A. Use adequate quantities of skilled workmen who are trained and experienced in their crafts and who are familiar with the specified requirements and methods needed to perform the work in this division.
- B. Install materials and equipment based upon actual dimensions and conditions at the project site. Field measure for materials or equipment requiring exact fit.
- C. Be responsible for the proper location and sizes of all slots, holes or openings in the building structure pertaining to the work in this division, and for the correct location of pipe sleeves.
- D. Perform work in accordance with good commercial practice. The good appearance of the finished work shall be of equivalent importance with its operation.
- E. Isolate all conduit, transformers and motors to insure an acceptable noise level free from objectionable vibration for all systems.

3.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Follow the manufacturer's directions in the delivery, storage and handling of equipment and materials.
- B. Equipment and materials shall be tightly covered and protected against dirt, water, chemical or mechanical injury and theft. Damaged equipment will not be accepted.
- C. After materials are installed, protect the installation until the work is completed and accepted by the Owner.

3.5 CLEANING UP

- A. Remove all shipping labels, dirt, paint, grease and stains from all equipment under this division of the Work. Remove debris as it accumulates. Upon completion of the Work, clean all electrical equipment and the entire electrical installation in order to present a first class electrical installation suitable for occupancy. No loose parts, scraps, tools nor debris shall be left on the premises.

3.6 CUTTING AND PATCHING

- A. Be responsible for the cost of cutting and patching required in connection with the work under this division of the specifications.
- B. Coordinate the work to eliminate unnecessary cutting of construction. Where it becomes necessary to cut through walls, floors, ceilings and other construction to permit installation of the work, or to repair defective work under this division, the costs for such cutting and patching shall be included in this division of the work. Comply with other applicable divisions of the specifications concerning the quality of cutting and patching.
- C. Where openings are cut through masonry walls, provide lintels or structural supports to protect the remaining masonry. Provide adequate support during the cutting operation to prevent any damage to the affected masonry.
- D. Cutting of structural members is not permitted unless the Engineer grants specific written permission.

3.7 FLASHINGS, SLEEVES, INSERTS

- A. Be responsible for maintaining the integrity of the waterproofing of conduit penetrations through roofs, exterior walls and floors.
- B. Be responsible for the installation of counterflashing of roof penetrations to provide a weatherproof installation.
- C. Install 22 gauge galvanized sheet iron sleeves for each conduit passing through floors. Extend sleeves 1-1/2 in. above the floor slab and cement watertight. The sizes of sleeves shall be installed to permit the subsequent insertion of the proper size conduits or raceways.

- D. Install galvanized wrought iron pipe sleeves around conduits and raceways that pass through concrete beams or walls and masonry exterior walls. The inside diameter of these sleeves shall be at least 1/2 in. greater than the outside diameters of the service pipes. After the pipes are installed in these sleeves, fill the annular space between pipes and sleeves with mastic. The completed installation shall be watertight.
- E. Be responsible for maintaining the fire rating of penetrations through walls, floors and ceilings.
- F. Waterproofing and fireproofing work shall conform to the requirements of other applicable sections of the specifications.

3.8 PAINTING

- A. Maintain original factory finish on all material and equipment installed under this division of the work unless specifically noted otherwise within the Contract Documents. Should the finish be marred in transit or during installation, it shall be re-finished to present a neat, workmanlike appearance. Leave equipment clean and free from any grease, dirt and rust and in a suitable condition for painting.

3.9 IDENTIFICATION OF ELECTRICAL EQUIPMENT

- A. Identify electrical equipment in accordance with the NEC, local authorities and in accordance with the requirements of the Contract Documents.
- B. Use laminated three-ply, engraved plastic nameplates with black surface and white interior core, at least 1/16 in. thick. Engraved lettering shall be condensed gothic at least 1/4 in. high and properly spaced for legible and easy reading. Attach plates to equipment with chromium-plated screws. Adhesive attachment is not acceptable. Identify the following items with engraved nameplates, located as follows:
 1. Each switch/fuse unit or circuit breaker in each main panel and each distribution panel - adjacent to switch/fuse unit or circuit breaker.
 2. Spares shall be labeled 'Spare'.
 3. Each branch circuit panel - on panel trim cover immediately above panel door.
 4. Each safety switch, relay cabinet, time clock - on outside of cover. Include the power source on safety switches.
 5. Each motor starter - on outside of cover.
 6. Each motor starter in motor control center on outside of cover.
 7. Any switch for load that cannot be seen from the control point - custom engraved on outside of switch coverplate.
- C. Custom engraving on cover plates for items noted above shall be equivalent to custom engraving as performed by Hubbell, or accepted substitute.
- D. Install adhesive arc flash warning labels on all equipment as required by the latest NFPA 70E. Each label shall show specific and correct information for specific equipment based on its arc flash calculations. Labels shall show the followings:
 1. Nominal system voltage.

2. Equipment/bus name, date prepared, and preparer's name and address.
 3. Arc flash boundary.
 4. Available arc flash incident energy and the corresponding working distance.
 5. Minimum arc rating of clothing.
 6. Site-specific level of PPE.
- E. Branch circuit panelboard directories shall be completely and properly typewritten, including room numbers. Room numbers and names shall be as finally designated at the jobsite.
- F. Refer to other sections of the specifications for conductor color-coding requirements.
- G. Refer to Section 26 05 33 for identifying of underground electrical work.

3.10 BALANCING OF PANELS

- A. At the completion of the installation of the electrical system, check each phase of all panels under full load and arrange loads such that all phases carry the proper proportion of load. Submit load readings to Engineer for review as part of project close out documentation.

3.11 RECORD DOCUMENTS

- A. Job set: Promptly following receipt of the Owner's Notice to Proceed, secure from the Engineer at no charge to the Contractor, one complete set of all Documents comprising the Contract.
- B. Final Record Documents: At a time nearing the completion of the work, secure from the Engineer at no charge to the Contractor one complete set of sepia transparencies of all Drawings in the Contract.
- C. Maintenance of Job Set: Immediately upon receipt of the job set described in paragraph above, identify each of the Documents with the title, "RECORD DOCUMENTS - JOB SET".
- D. Preservation:
1. Considering the Contract completion time, the probable number of occasions upon which the job set must be taken out for the new entries and for examination, and the conditions under which these activities will be performed, devise a suitable method for protecting the job set to the approval of the Engineer.
 2. Do not use the job set for any purpose except entry of new data and for review by the Engineer, from start of transfer of data to final Project Record Documents.
 3. Maintain the job set at the site of Work where the Engineer designates that site.
- E. Making Entries on Drawings:
1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required.
 2. Date all entries.
 3. Call attention to the entry by a 'cloud' drawn around the area or areas affected.

4. In the event of overlapping changes, use different colors for the overlapping changes.
5. All equipment shall be clearly indicated in its installed location. Exposed items or those easily accessible, as above lay-in ceilings, may be located to scale. Concealed items not readily accessible, such as underground piping, shall be located by dimension.

F. Transfer of Data to Final Project Documents:

1. Approval of recorded data prior to transfer:
 - a. Following receipt of the transparencies described above, and prior to beginning transfer of recorded data thereto, secure the Engineer's approval of all recorded data.
 - b. Make required revisions.
2. Transfer of Data to Drawings:
 - a. Carefully transfer change data shown on the job set of Record Drawings to the corresponding transparencies, coordinating the changes as required.
 - b. Clearly indicate at each affected detail and other drawing a full description of changes made during construction, and the actual location of items described above.
 - c. Call attention to each entry by drawing a 'cloud' around the area or areas affected.
 - d. Make changes neatly, consistently, and with the proper media to assure longevity and clear reproduction.

G. Review and Submittal:

1. Submit the completed set of Project Record Documents to the Engineer as described above.
2. Participate in review meetings as required.
3. Make required changes and promptly deliver the final Project Record Documents to the Engineer.

3.12 OPERATIONS AND MAINTENANCE DATA

- A. Accumulate, as the job progresses, the following data, in duplicate, prepared in a neat brochure or packet folder, and deliver to the Engineer for checking and subsequent delivery to the Owner.
1. Manufacturers' warranties, guarantees, service manuals, and operating instructions for equipment and materials covered by this division of the specifications.
 2. Copies of approved Shop Drawings.
 3. Any and all other data and/or Drawings required during construction.
 4. Repair parts list of all major items and equipment including name, address, and telephone number of local supplier and agent.

3.13 INSTRUCTION OF OWNER'S PERSONNEL

- A. Provide the services of competent technicians acceptable to the Engineer to instruct representatives of the Owner in the complete and detailed operation of each item of equipment, and each system. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results. Upon completion of these

instructions, the Contractor shall obtain a Letter of Release, acknowledged by the Owner or his Authorized Representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.

- B. Be responsible for proper maintenance of equipment and systems until the instructions have been given to the Owner's personnel and the letter of release acknowledged.
- C. In providing the instructions to the Owner's personnel, follow the written operating and maintenance manuals in all instances, and familiarize the Owner's personnel with such manuals. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturers' operation and maintenance manuals, parts lists (with sources identified), and other data as appropriate for each system, and as required elsewhere in the Specifications to be furnished to the Owner prior to final acceptance of the project.

3.14 LOCAL PARTS AND SERVICE

- A. Each item of equipment furnished on this project shall have local representation, factory-authorized service, and an adequate stock of repair parts. "Local" shall be defined, for this purpose, as "within 150 miles of the project site".

3.15 INSTALLATION INSPECTIONS AND CERTIFICATIONS

- A. Obtain timely inspections of the installation by the constituted authorities. Remedy any deficiencies to the satisfaction of the inspection authority.
- B. Upon final completion of the Work, obtain certificates of acceptance from the constituted authorities. Deliver the certificates to the Engineer for transmission to the Owner.

3.16 OPERATION PRIOR TO ACCEPTANCE

- A. When any equipment is operable, and it is to the advantage of the Contractor to operate the equipment, the Contractor may do so provided that the Contractor properly supervises the operation and retains full responsibility for the equipment operated. Regardless of whether or not the equipment has or has not been operated, clean the equipment properly; make required adjustments, and complete punch list items before final acceptance by the Owner.
- B. The date of acceptance by the Engineer, for beneficial use by the Owner, shall be the beginning date of the warranty period.

3.17 ACCEPTANCE OF THE WORK

- A. The Work, when completed, will be accepted in a finished, perfect and undamaged state only. Provide for protection of the Work during its progress, and if damaged, do all patching or replacing necessary to its full and satisfactory completion.

3.18 WARRANTY

- A. Furnish a written certificate, guaranteeing all materials, equipment and labor to be free of all defects for a period of one year from the date of final acceptance by the Owner of the Work, and guarantee that if any defects appear within the stipulated guarantee period, such work shall be replaced without charge.

- B. This guarantee shall be extended to include the capacity and integrated performance of all component parts of the various systems.

3.19 FINALLY

- A. It is the intention that this Specification provide a complete installation. Include all accessory construction and apparatus necessary to the operation and testing of the work under this division. The omission of specific reference to any part of the work necessary for such complete installation shall not relieve this Contractor from furnishing and installing such parts.

END OF SECTION

SECTION 26 05 11

WORK IN EXISTING BUILDING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Furnish all labor, materials, services, equipment, and appliances required in conjunction with the work in existing buildings as indicated in the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use materials to match existing construction unless specified elsewhere in these Contract Documents. Materials shall comply with local codes, be UL listed, and be properly applied for their intended function.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

- A. It is recommended that the Contractor inspect the jobsite prior to bidding and be familiar with all existing conditions. Include the cost of the work required to accommodate the existing conditions in the bid proposal.
- B. Obtain data related to existing facilities from existing documents, measurements, notations, photographs, surveys and other observations at the site.
- C. Relocate existing items as required to accommodate the new construction. Remove, relocate and reconnect equipment and accessories that are to be reused.
- D. Coordinate the Work with other divisions of the specifications. Determine which items and equipment are to remain, to be relocated or be removed, and perform all work consistent with the Scope of Work.
- E. Loads that exist and are to remain shall be connected to the new distribution system as shown on the Drawings or as required to maintain their proper operation.
- F. Refer to other divisions of the specifications and determine equipment that requires power to be disconnected, or power to be relocated and disconnect power and relocate power to this equipment.
- G. Remove all conductors and exposed conduit rendered unused back to the source of supply.
- H. Perform splices as required to maintain circuit continuity to existing devices or equipment to remain in service.

3.2 DISRUPTION OF EXISTING FUNCTIONS

- A. Access: Access to and use of the existing facilities and site will be restricted, and shall be under the direction and control of the Owner.
- B. Disruptions: Maintain existing electrical, communications, alarm, and other existing systems, and maintain existing functions in service except for scheduled disruptions. Where existing functions to remain in use are disrupted, they shall be fully restored after disruption, in full compliance with this division of the specifications for new work.
- C. Scheduling of Disruptions: Seek and obtain approval two weeks in advance of the event date. Indicate date of event, starting time, and duration of each required disruption.
- D. Notice of Disruption: Date, time and duration of each disruption shall be subject to the Owner's prior approval, and shall include the following information in the form of a memorandum submitted by the Contractor to the Engineer for approval by the Owner:

FACILITY/SYSTEM	STARTING DATE	TIME	DURATION
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- E. Emergency Disruptions: When circumstances preclude obtaining advance approval as specified above, make request immediately upon knowledge of the requirement, and perform work so as to cause the minimum amount of disruption, for the minimum duration.
- F. Notification: Notify the Engineer and the Owner immediately by telephone and then in writing, as changes and additions to the scheduled disruption requirements become known.
- G. Duration: Complete as large a portion of the work as possible before initiating disruption and perform only that work necessary so as to minimize duration of disruption. Maintain adequate personnel, supplies, materials, equipment, tools, and other resources at job site to avoid unnecessary delay in resumption of normal service.

3.3 SALVAGE, DEMOLITION AND RELOCATION

- A. General
 - 1. Modify, remove, or relocate materials and items indicated in the Contract Documents and required by the installation of new facilities.
 - 2. Working jointly with the work under other divisions of the specifications establish and mark salvage and demolition items before commencing work; report items scheduled for relocation, reinstallation or reuse, which are found to be in damaged condition; await further instructions from the Owner's Representative and/or the Engineer before commencing with work.
 - 3. Owner shall have first right of refusal for all material and equipment. Deliver salvaged material accepted by the Owner to destinations on the premises as directed and remove material rejected by the Owner from the site.
- B. Relocations
 - 1. Make minor relocations necessitated by the conditions at the site or as directed by the Engineer, without additional cost to the Owner.

2. Repair and restore to good functional condition equipment, materials and items scheduled for relocation, which are damaged during dismantling or reassembly operations.
 3. New materials and items of similar design and quality may be substituted for materials and items indicated to be relocated upon approval of shop drawings, product data, and samples.
 4. Remove carefully, in reverse order to original assembly or placement, items that are to be relocated.
 5. Protect items until relocation is complete.
 6. Clean and repair items to be relocated, and provide new materials, fittings, and appurtenances required to complete the relocations and to restore items to good operating order.
 7. Perform the relocation work in accordance with applicable sections of these specifications, utilizing skilled workers.
- C. Relocating Devices: Remove and reinstall, in locations designated by the Owner's Representative and the Engineer, temperature control system devices, relays, wire, conduit, fixtures, equipment and other devices required for the operation of the various systems that are installed in existing-to-be-removed construction.

3.4 EXISTING RACEWAYS

- A. Reuse raceways where possible and where permitted by local codes. Rework raceways to meet code requirements. Secure all raceways that are not properly supported. Paint raceways when exposed to view to match surroundings if existing finish is damaged or soiled.
- B. Fasten existing boxes and raceways securely to provide proper support.

3.5 NEW RACEWAYS

- A. Provide new raceways where required to provide wiring as indicated in the Contract Documents.
- B. Where raceways must be exposed to view, use wiremold, securely fastened, and painted to match surroundings. Provide number of coats of paint as required to cover prime coat of original finish of wiremold.

3.6 EXISTING WIRING DEVICES

- A. Inspect existing wiring devices, which are to be reused, for damage and replace as necessary.
- B. Clean existing wiring devices, to be reused, to a "like- new" condition.
- C. Replace damaged wiring devices cover plates with new cover plates that match the existing.
- D. Tighten wire terminations at reused wiring devices.

- E. Replace existing lighting switches rated 15 amperes with new switches rated 20 amperes when the load to be controlled exceeds 12 amperes.
- F. Replace existing receptacles rated 15 amperes with new receptacles rated 20 amperes when the load to be connected exceeds 12 amperes.

3.7 EXISTING LIGHTING FIXTURES

- A. Service existing lighting fixtures as follows:
 - 1. Clean reflective surfaces, lenses, and sight exposed portions.
 - 2. Re-lamp with new lamps of the same types removed.
 - 3. Repair or replace lamp holders, ballasts, wiring, and door latching and hinging mechanisms.
 - 4. Reconnect to branch circuit wiring, tighten connections.
- B. Existing lighting fixtures may be replaced with new fixtures in lieu of the actions required by Paragraph 3.8 A above, if, in the Contractor's opinion, costs to the Owner would be lower.

3.8 EXISTING CEILINGS

- A. Provide a typewritten list of existing damaged ceilings and ceiling tiles. Disregard rooms in which ceilings are to be repaired and replaced. Correlate list to room numbers indicated on drawings.
- B. Mark damaged ceilings and ceiling tiles with easily removable red "stick-on" labels, minimum size two square in.
- C. Submit list prior to commencing work. Do not start work until Engineer and Owner review list; otherwise repair and replace damaged ceilings and ceiling tiles.

3.9 EXISTING PANELBOARDS

- A. Service existing panelboards to be reused as follows:
 - 1. Clean interiors and exteriors.
 - 2. Touch-up damaged finishes with manufacturer's matching touch-up paint.
 - 3. Inspect for component damage and repair or replace as necessary.
 - 4. Tighten conduit and wire terminations.
 - 5. Verify panelboards and panelboard feeders are of adequate capacity for loads to be served as follows:
 - a. Activate loads connected to panelboards to simulate 100 percent demand.
 - b. Measure and record amperage readings of phase and neutral conductors of panelboards feeders.
 - c. Provide typewritten record of recorded measurements to the Engineer for review.
 - 6. Rebalance loads as specified in other sections of the specifications to provide for evenly balanced phases.
 - 7. Provide new typewritten circuit directories.

8. Provide new panelboard identification labels if panelboard designation changes or if no labels exist.

3.10 EXISTING WIRING

- A. Inspect existing wiring to be reused for damage. Repair or replace damaged wiring.
- B. Secure and label existing wiring that is to be disturbed.
- C. Tighten existing wiring terminations and connections.

3.11 EXISTING FOUNDATIONS AND FLOORS

- A. Prior to coring, penetrating or cutting of existing foundations or floors, the Contractor shall notify the Engineer in writing and request all as-built and building record drawings showing the location of post tension cables in slabs and subsequent floors. In the event post tension cables do exist in the building, the Contractor shall X-ray the area to be cut, cored or penetrated. Two copies of the X-ray shall be forwarded to the Engineer and written approval issued to the Contractor prior to proceeding with the work.
- B. If no as-built or record building drawings are available, then the Contractor shall X-ray the area to be cut, cored or penetrated. Two copies of the X-ray shall be forwarded to the Engineer and written approval issued to the Contractor prior to proceeding with the work.

END OF SECTION

SECTION 26 05 12

MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Refer to Section 21 00 10 - BASIC FIRE PROTECTION REQUIREMENTS.
- C. Refer to Section 22 00 10 - BASIC PLUMBING REQUIREMENTS.
- D. Refer to Section 23 00 10 - BASIC MECHANICAL REQUIREMENTS.

1.2 SUMMARY

- A. This Section describes the coordination between the Fire Protection, Plumbing, Mechanical and Electrical portions of the work.
- B. This Section is included under the Division 21 portion of the Specifications as Section 21 05 12, under the Division 22 portion of the Specifications as Section 22 05 12, under the Division 23 portion of the Specifications as Section 23 05 12, and under the Division 26 portion of the Specifications as Section 26 05 12.

1.3 WORK INCLUDED

- A. Responsibility: Unless otherwise indicated, motors and controls shall be furnished, set in place and wired in accordance with the following schedule. **This schedule may include equipment and systems that are not required for this project. Only the equipment and systems that are required on the drawings and/or specified elsewhere will be required by this section:**

ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
1. Equipment Motors	21/22/23	21/22/23	26
2. Magnetic Motor Starters			
a. Automatically controlled, with or without HOA switches	21/22/23	26	Notes 1,3,5
b. Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	21/22/23	22/23	Notes 1,3,5
c. Manually controlled	21/22/23	26	Notes 1,3,5
d. Manually controlled and furnished as part of factory wired equipment	21/22/23	26	Notes 1,3,5
e. Furnished in Motor Control Centers	26	26	Notes 1,3,5
3. Variable Speed (Frequency) AC Drives	22/23	26	Notes 1,4,5

ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
4. Line voltage thermostats, time clocks, etc., not connected to control panel systems	23	26	23
5. Electric thermostats, time clocks, remote bulb thermostats, motorized valves, float controls, etc. which are an integral part or directly attached to ducts, pipes, etc.	22/23	22/23	22/23
6. Temperature control panels and time switches mounted on temperature control panels	23	23	23
7. Motorized valves, motorized dampers, solenoid valves, EP and PE switches, etc.	23	23	Note 1
8. Alarm bells furnished with equipment installed by Division 22 or 23	22/23	22/23	22/23
9. Wiring to obtain power for control circuits, including circuit breaker	21/22/23	21/22/23	21/22/23
10. Low voltage controls	21/22/23	21/22/23	21/22/23
11. Fire protection system (sprinkler) controls	21	21	Note 8
12. Fire and smoke detectors installed on mechanical units and in ductwork	28	23	Note 8
13. All relays required for fan shutdown, motorized dampers, smoke control devices, and other items integral with HVAC equipment to provide operation and control of HVAC equipment	23	23	Note 1
14. Smoke dampers, and combination fire/smoke dampers	23	23	Note 7
15. Boiler and water heater controls, boiler burner controls panels	22/23	22/23	22/23
16. Pushbutton stations, pilot lights	22/23	22/23	22/23
17. Heat Tape	21/22/23	21/22/23	26
18. Disconnect switches, manual operating switches furnished as a part of the equipment	21/22/23	21/22/23	Notes 1,5
19. Disconnect switches, manual operating switches furnished separate from equipment	26	26	26
20. Multispeed switches	23	23	26
21. Thermal overloads	21/22/23	21/22/23	21/22/23
22. Control relays, transformers	21/22/23	21/22/23	21/22/23
23. Refrigeration cycle, cooling tower and controls	23	23	23
24. Tamper switches for fire protection (sprinkler) system	21	21	28
25. Flow and/or pressure switches for fire protection (sprinkler) system	21	21	28
26. Alarm bells or horns for fire protection (sprinkler) system	21	21	28

- NOTES:
- (1) Power wiring as defined in Section 26 29 13 of the specifications shall be provided under Division 26; control wiring as defined in Section 26 29 13 of the specifications shall be provided under Division 21/22/23.
 - (2) Wiring from alarm contacts to alarm systems provided by Division 26, wiring from auxiliary contacts to air handling system controls provided by Division 23. Division 26 shall provide power to smoke detector. Smoke detectors required for all air handling systems 2000 CFM or greater. Refer to other Division 23 specifications, Division 26 and Drawings for more specific requirements.
 - (3) For requirements for Magnetic Motor Starters, refer to Section 23 89 65 - MOTOR CONTROLLERS.
 - (4) For requirements for Variable Speed (Frequency) AC drives, refer to Section 23 89 65 - MOTOR CONTROLLERS.
 - (5) Disconnect switches, operating switches, starters and other similar items that are factory-mounted, as a part of complete assembly, shall comply with applicable provisions of the National Electric Code. All such disconnect switches shall be fused.
 - (6) Power wiring from energy source to controllers and automatic transfer switch shall be provided under Division 26. Interconnection power and control wiring from controllers and automatic transfer switch to pumps shall be provided under Division 21, 22 or 23 and conforming to Division 26 specifications. Control wiring from automatic transfer switch to generator starter shall be provided under Division 26.
 - (7) Division 26 will provide power to all smoke and combination fire/smoke dampers, and Division 28 will provide control for all such dampers using area smoke detectors.
 - (8) Wiring for sprinkler system controls to be provided by Division 21. Wiring from devices to Fire Alarm System to be provided by Division 28.

B. CONNECTIONS: Make all connections to controls that are directly attached to ducts, piping and mechanical equipment with flexible connections.

C. PRECEDENCE

1. In general, piping systems that require a stated grade for proper operation shall have precedence over other systems.
2. Precedence for pipe, conduit and duct systems shall be as follows.
 - a. Building lines
 - b. Structural members
 - c. Soil and drain piping
 - d. Vent piping
 - e. Steam piping
 - f. Condensate piping
 - g. Refrigerant piping
 - h. Electrical bus duct
 - i. Supply ductwork
 - j. Return ductwork
 - k. Exhaust ductwork
 - l. Chilled water and heating water piping
 - m. Automatic Fire Protection Sprinkler Piping
 - n. Natural gas piping
 - o. Domestic hot and cold water piping
 - p. Electrical conduit

3. Lighting Fixtures shall have precedence over air grilles and diffusers.

D. FINAL INSPECTION AND REPORT

1. At the completion of the work, there shall be a meeting of the Fire Protection, Plumbing, Mechanical, Electrical Fire Alarm and Temperature Control Contractors, representatives of mechanical and electrical equipment manufactures whose equipment was actually installed on the project, and similarly-involved individuals, who shall thoroughly inspect all systems, and who shall mutually agree that all equipment has been properly wired and installed, and that all temperature and safety controls are properly functioning. A written report of this meeting, listing those in attendance, and the companies that they represent, shall be filed with the Owner and Engineer.

END OF SECTION

SECTION 26 05 19

WIRES AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Provide labor, materials, services, equipment and appliances required in conjunction with the installation of wire and cable systems as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide conductors made of soft-drawn-annealed copper with conductivity not less than that of 98 percent pure copper. Conductors #12 gauge and smaller shall be solid. Conductors No. 10 gauge and larger shall be stranded.
- B. Utilize conductors with insulation rated at 600 volts and insulated with type 'THHN' insulation in dry locations and type "THWN" in wet locations . Wire in fixture channels and other special locations shall be as specifically rated for temperature in Article 300 in the NEC.
- C. Minimum wire sizes shall be in accordance with other requirements of the specifications and as follows: For 20 ampere branch circuits #12 gauge, except that home runs greater than 50 ft. from the panel to the first outlet box on 120/208 volt shall be #10 gauge. Where home runs are greater than 100 ft. from the panel to the first outlet box, on 277-volt circuits wire shall be #10 gauge.
- D. All wire shall be color-coded. Mark conductors on each end with a 1 in. band of colored pressure-sensitive plastic tape or by the use of brilliant waterproof lacquer, applied according to manufacturer's instructions. Colors for each phase and the neutral shall be consistent throughout the system in accordance with the requirements of this section.
- E. Conductor sizes shown on the Contract Documents are selected based upon use with 75 degrees C terminations. Furnish terminations, which are UL listed for 75°C, or derate conductors for use at 60°C. Use of 90°C terminations is acceptable, but conductor must be sized at the 75°C rating. Do not use 90°C rating for conductors.
- F. Armored cable types AC and BX are specifically not allowed.
- G. Armored cable type MC is specifically not allowed.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

- A. Place an equivalent number of conductors for each phase, neutral and ground of a circuit in same raceway or cable.
- B. Do not share neutral conductors between branch circuits connected to single pole circuit breakers unless shown otherwise on drawings.
- C. Splice only in junction or outlet boxes.
- D. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- E. Make conductor lengths equal for parallel circuits.
- F. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling #4 gauge and larger wires.
- G. When inserting conductors in raceways, comply with the following:
 - 1. Raceways shall first be installed as a complete raceway system without conductors.
 - 2. Do not install pull wires and conductors until the raceway system is in place.
 - 3. Do not use cleaning agents and lubricants that have a deleterious effect on the conductors.
 - 4. Completely and thoroughly swab raceway system before installing conductors.

3.2 PHASING

- A. Identify wire and cable for feeders and branch circuits for general power and lighting with a visible color code in accordance with the requirements of this section as follows:

<u>120/208 Volt</u>	<u>277/480 Volt</u>
Phase A - Black	Phase A - Brown
Phase B - Red	Phase B - Orange
Phase C - Blue	Phase C - Yellow
Neutral - White	Neutral - Gray
Ground - Green	
- B. Provide green or bare grounding conductor identification for grounding conductors. Identification of all ungrounded conductors at junction boxes, wireways, and/or terminations may be by means of colored tape or painting when color-coded conductors as specified above are not available.
- C. Phasing of the complete electrical installation shall be connected and maintained the same throughout the power distribution system. Where the project is an addition or modification to an existing facility, the electrical distribution system phasing shall be made the same as the existing.

- D. Switchgear, safety switches, motor starters, plug-in type bus duct, lighting and power panels and power receptacles shall have all the same phase arrangements throughout the facility.

3.3 INSTALLATION

- A. Install conductors in a neat and workmanlike manner to meet code requirements and make runs continuous without weld, splice, or joint between boxes. Do not install wires in conduit unless the entire system of conduit and outlet boxes is permanently in place. Pull conductors using a UL approved wire lubricant.
- B. Provide conductors continuous from outlet to outlet with no splices except at outlets. Leave sufficient wire at all outlets to make connections without straining.
- C. Deliver cable and wire to the project in original packages. Conductors with insulation showing deterioration within one year after final completion and acceptance of the Work shall be removed and replaced at no cost to Owner.
- D. Thoroughly clean wires before installing lugs and connectors.
- E. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- F. Terminate spare conductors with electrical tape.
- G. Torque test conductor connections and terminations to manufacturer's recommended values.
- H. Where outlets only are indicated, leave 48-in. leads of conductors, for connection to equipment. Identify all conductors' circuit numbers with Brady tape at terminals and junctions.
- I. Where more than three current-carrying conductors are installed in a raceway, use larger size conductor and appropriate larger size raceway to comply with Article 310 of the National Electrical Code.
- J. Where conductor is installed in an environment where the ambient temperature will exceed 86°F, use larger size conductor and appropriate larger size raceway to comply with Article 310 of the National Electrical Code.
- K. Test all circuits for grounds. Prove and test energy available at the load side of disconnect switches and at the final point of connection to driven equipment. Make all necessary and reasonable tests as required by the Engineer to prove the integrity of work and leave the complete electrical installation ready for operation.

END OF SECTION

SECTION 26 05 20

WIRE CONNECTION AND DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Provide labor, materials, services, equipment and appliances required in conjunction with the installation of wire connections and devices systems as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Make cable and wire connections for splicing or terminating with compression deforming type connectors as manufactured by Burndy Corp., Thomas & Betts Co., Inc., Dossert Manufacturing Corp., IlSCO Corp., or accepted substitute. Connectors for cable sizes 250 Kcmil and larger shall be the long barrel type for double indentation. Soldered connections will not be permitted. Twist-on insulated connectors, of proper size, and resistant to vibration, may be used. Use twist-on connectors as manufactured by Minnesota Mining and Manufacturing Co., Thomas & Betts Co., Inc., Ideal Industries, Inc., or approved equivalent.
- B. Provide terminal connectors with the hole sizes and spacing in accordance with NEMA standards. Provide terminal connectors with two holes in tongue for use on conductor sizes 250 Kcmil and larger. Terminal connectors are not required for connections to the circuit breakers in the lighting and/or receptacle panels.
- C. Insulate connections made with non-insulated connectors with three layers of plastic tape, each layer being half-lapped. Use No. 35+ plastic tape as manufactured by Minnesota Mining and Manufacturing Co., or similar and equivalent plastic tape as manufactured by Plymouth Rubber Co.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Make all electrical power and control connections to equipment furnished under other divisions of the specifications and furnish wiring, conduit, outlet boxes, disconnect switches, etc., as required for same. Check General Construction, Controls, Plumbing, Heating, and Air Conditioning, etc. plans and specifications to determine the amount of such wiring required and include cost of same in bid. Verify locations, horsepower, voltages, etc., of all

equipment as the job progresses. If a conflict arises in wiring, ask the Engineer immediately for clarification.

- B. Provide branch circuits and connections to all motors furnished to this project. Provide all disconnect switches as shown and where required by national or local codes. In general, all wiring shall be in conduit, with a short section of flexible conduit at each motor. Securely attach conduit to flexible conduit. When the motor is an integral part of equipment, isolate with a short section of flexible metal conduit to prevent vibration and/or noise amplification to the building structure. If the motor is adjustable, an additional length of flexible metal conduit shall be installed at the motor. Connect a ground wire from the conduit termination to the motor frame on the inside of the flexible conduit. Use approved grounding lugs or clamps on the conduit connection.
- C. Branch circuits and connections to all electrically operated equipment are included in this contract, whether or not specifically mentioned. Check, on the job, for further details on Plumbing, Heating, and Air Conditioning equipment as project progresses. Ground equipment in an approved manner.
- D. Major equipment furnished under the mechanical and other sections of the specifications may require different rough-in requirements than indicated on the plans due to the 'or equivalent' equipment clause. Secure detailed drawings from the trade furnishing the equipment to determine actual rough-in locations, conduit and conductor requirements.
- E. Before connecting equipment, check the nameplate data against the information shown on the Drawings. Call any discrepancies to the attention of the Engineer.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Furnish all labor, materials, services, equipment and appliances required in conjunction with the installation of a grounding system as indicated in the Contract Documents.

PART 3 - EXECUTION

2.1 INSTALLATION

- A. Ground electrical work in accordance with NEC Article 250, local codes as specified herein, and as shown on the Drawings.
- B. Use rigid metal conduit and electrical metallic tubing as equipment grounding conductors. Make-up couplings wrench tight. Install grounding conductor in nonmetallic raceways and under floor ducts.
- C. Install equipment-grounding conductors in nonmetallic raceways. Install equipment grounding conductors in metallic raceways where noted on the drawings.
- D. Where connections are made to motors or equipment with flexible metal conduit, grounding conductor shall be stranded copper conductor within the conduit, bonded to the equipment and to the rigid metal raceway system. Size conductor in accordance with NEC, Article 250.
- E. At each convenience outlet, install a grounding clip attached to the outlet box and leave a sufficient length of No. 12 wire with green colored insulation to connect to the grounding terminal of the receptacle. Grounding clip shall be equivalent to Steel City Type G. This requirement may be deleted if automatic grounding clip receptacle meeting NEC Article 250.

2.2 COORDINATION

- A. Coordinate the work under this section with the work under other divisions of the specifications.

END OF SECTION

SECTION 26 05 27

SEALING OF PENETRATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Provide labor, materials, services, equipment and appliances required in conjunction with sealing of penetrations as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Samples: Provide samples upon written request.
- B. Product Data: Manufacturer's specifications and installation instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Acceptable Manufacturers:
 - 1. Caulk and Putty: 3M's No. CP-25 and No. CP-303 synthetic elastomers.
 - 2. Wrap/Strip: 3M's No. FS-195 organic/inorganic, fire resistive sheet with aluminum foil on one side.
 - 3. Composite Sheet: 3M's No. CS-195 organic/inorganic fire resistive elastomeric sheet, bonded on one side with 28-gauge galvanized steel and the other side with reinforced hexagonal shaped steel wire mesh and covered with aluminum foil.
 - 4. Thunderline Model "LS/Link-Seal" seals, of the required size and number of links, shall be used on all conduit penetrations of exterior walls. Similar fittings by O.Z./Gedney shall be considered approved equivalents.

2.2 ROOF PENETRATION SYSTEMS

- A. General: Construct roof penetration systems utilizing the "Alumi-Flash" system by Portals Plus, Inc., or equal by Thy-Curb.
- B. Each roof penetration shall include a spun aluminum base ("High" size if required due to the existing roof construction and any insulation thickness) and an EPDM rubber cap. Each rubber cap shall have a pre-molded pipe opening and shall be selected based on the actual pipe or conduit size required at each location. Secure each rubber cap to each pipe or conduit with the manufacturer's recommended stainless steel gear clamp.
- C. Manufacturer: Subject to compliance with requirements, provide roof penetration systems of one of the following:
 - 1. Portals Plus, Inc.
 - 2. Thycurb Div.; Thybar Corp.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Review the detailed requirements of the UL through penetration fire stop assembly to be used and verify dimensional requirements such as maximum conduit size, conduit spacing, maximum opening size, minimum length of sleeve, etc.
- B. For sealing of sleeves on or below grade and in wet locations, install link seals around all conduit penetrations properly sealing the annular space between the sleeve and the conduit to provide a waterproof seal.
- C. For sealing of sleeves above grade and in dry/damp locations, use specified fire stop material and install per manufacturer's instructions and in conformance with UL requirements.
- D. Attach an adhesive warning label identifying the fire stop assembly and warning against removal without proper resealing.
- E. Seal floor, wall and ceiling penetrations or fire rated assemblies in above grade and in dry/damp locations, both horizontal and vertical, utilizing intumescent (expand when heated) materials designed to be applied as a fire, cold smoke, noxious gas, and water sealant. Penetrations shall meet the requirements of ANSI/UL 1479 "Fire Tests of Through-Penetration Firestops".

END OF SECTION

SECTION 26 05 29

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Furnish all labor, materials, services, equipment and appliances required in conjunction with installation of supporting devices as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's engineering brochures.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Kindorf
- B. Unistrut
- C. Superstrut
- D. Powerstrut

2.2 MATERIALS

- A. Continuous slotted channel: 12 gauge steel with electro-galvanizing and gold zinc dichromate barrier bases and dimensions as required for application.
- B. Hanger rods: Continuous thread, electro-galvanized, steel, with gold zinc dichromate barrier, sizes as required for loads imposed.
- C. Hex head cap screws and nuts: No. H-113 and No. 114, respectively.
- D. One-hole pipe straps: Series HS-100, galvanized steel.
- E. Single bolt channel pipe straps: Steel, with machine screw and nut, Series C-105 and Series C-106.
- F. Lay-in pipe hanger: Series C-149.
- G. Conduit and pipe hanger: Series 6H.
- H. Beam clamps: Series 500, RC, EC and PC as applicable.

- I. Concrete inserts, spot: Series D-256 or D-255.
- J. Concrete inserts, channel: Series D-980 or Series D-986.
- K. Riser clamps: Series C-210.
- L. Cable supports: O.Z./Gedney Type S.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Carefully lay out supporting devices to coordinate with the work under other divisions of the specifications.
- B. Securely fasten and support conduits and raceways to the building structure.
- C. Suspend horizontal runs of conduits and raceways from the floor and roof construction by rod hangers spaced 10 ft. or less on centers for sizes 2-1/2 in. and greater, and 9 ft. or less on centers for 2 in. and smaller.
- D. Fasten single runs of conduit to the structure with one-hole pipe straps and beam clamps or hang on rod hangers.
- E. Support multiple runs of conduit and raceways from continuous channel inserts or from trapeze hangers constructed of rod hangers and channels.
- F. Fasten single conduits to rod hangers with adjustable lay-in pipe hangers or for conduits of sizes 2 in. and smaller with Series 6H pipe hangers.
- G. Fasten conduits to channels with pipe channel straps.
- H. Support conduits and raceways within 3 ft. of each bend, of each termination, and at other intervals to maintain horizontal and vertical alignment without sag and deformation.
- I. Do not use cable, strap, or wire hangers and fasteners.
- J. Provide riser clamps for conduits at floor lines. Provide wire and cable supports in pull boxes for risers in accordance with NEC.
- K. Install supports to permit equivalently distributed expansion and contraction of conduits and raceways with expansion joints. Use guides consisting of saddles, U-bolts and anchors designed for equivalent effectiveness for both longitudinal and transverse thrusts. Submit complete details for review.
- L. Do not support conduits and raceways from equipment connections.
- M. Provide special supports with vibration dampers to minimize transmission of vibrations and noises, where required.

- N. Provide hangers, racks, cable cleats, and supports for wires and cables in cable chambers and other locations to make a neat and substantial installation.
- O. Provide steel angle and channel supports to the floor and structure for panelboards, cabinets, pull and junction boxes. Provide independent support from entering conduits and raceways.
- P. Provide supports as specified for conduits and raceways for outlet boxes and pull boxes 100 cubic in. and smaller.
- Q. Paint all cuts, breaks, welds and other points where the rust inhibiting coating of supports is damaged.
- R. Provide supports sized for the ultimate loads to be imposed.
- S. Anchor supporting devices with:
 - 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.
- T. Provide supports with hot-dipped galvanized finish in outdoor and wet locations.
- U. Pipe and conduit supports:
 - 1. Single run pipe and conduits, 2-1/2 in. O.D. and less, shall have Type SS-8R/SS-8C as manufactured by Portable Pipe Hangers, Inc., or approved equivalent, spaced at maximum eight ft. on center and installed on roof pads if required by the roofing manufacturer.
 - 2. Multiple run pipe and conduits larger than 2-1/2 in. O.D. shall have Type PS, PSE, PP-10 with Roller, or PP-10 with Bar, as manufactured by Portable Pipe Hangers, Inc., or approved equivalent, spaced at maximum eight ft. on center and installed on roof pads if required by the roofing manufacturer. All conduits shall be held in place with clips on bars.

END OF SECTION

SECTION 26 05 32

PULL AND JUNCTION BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Provide labor, materials, services, equipment and appliances required in conjunction with the installation of pull and junction boxes as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pull boxes and junction boxes used on concealed runs of conduit in walls and over ceilings shall be of code gauge galvanized steel with sheet steel covers. Pull boxes in floors shall be of galvanized malleable cast iron, with gasketed covers. Exposed pull boxes or junction boxes installed outdoors shall be weatherproof and shall be provided with watertight gasketed covers fastened with corrosion resistant screws.
- B. Pull Boxes and Junction Boxes: Metal construction conforming to National Electrical Code, with screw-on or hinged cover. Use hinged cover for boxes larger than 12 in. in any dimension.
- C. Flush-Mounted Pull Boxes: Provide overlapping covers with flush-head cover retaining screws, prime coated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use separate pull boxes and junction boxes for electric power, control, lighting, computer and communication systems.
- B. Install pull boxes and junction boxes where required by the National Electrical Code and wherever required to overcome mechanical difficulties.
- C. Install pull boxes in interior conduit at not more than 100 ft. apart when junction or outlet boxes do not break conduit runs.
- D. Size pull boxes and junction boxes to best meet the needs of the particular situation and/or location and to comply with the National Electrical Code.

- E. Coordinate the work in this section with the work under other divisions of this specification.

END OF SECTION

SECTION 26 05 33

CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Provide labor, materials, services, equipment, and appliances required in conjunction with the installation of conduit systems as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications and product data for products to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Rigid Metal Conduit: Heavy-wall, mild steel tube with metallic corrosion-resistant coating on interior and exterior, hot-dipped galvanized, free from defects and manufactured in accordance with ANSI standards, and UL listed.
- B. PVC Coated Rigid Metal Conduit:
 - 1. Hot dip galvanized inside and out. Factory-cut threads shall be protected with hot galvanized threads and a clear urethane coating. Thread protectors shall be used on the exposed threads. The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid galvanized steel conduit. The PVC coating shall be gray, 40 mils in thickness, continuous over the entire length of the conduit except at the threads, and be free of blisters, bubbles, or pinholes and manufactured in accordance with UL 6 Standard for Safety, Rigid Metal Conduit.
- C. Electric Metallic Tubing (EMT): Welded steel tubing formed of low carbon steel, electro-galvanized exterior, inside coated with a thick, baked, tough elastic low-friction coating of enamel, and UL approved.
- D. Intermediate Metal Conduit (IMC): Manufactured in accordance with UL 1242 with interior coating of silicone epoxy ester lubricant.
- E. Flexible Metal Conduit: Single strip helically wound interlocking galvanized steel, UL listed; provide liquid tight with extruded polyvinyl jacket in damp and wet locations and in kitchens.
- F. Rigid Nonmetallic Conduit:
 - 1. Direct buried - Schedule 40, UL listed.
 - 2. Concrete encased - Schedule 20, UL listed.
- G. Elbows and Bends:

1. Rigid nonmetallic conduit systems - PVC coated rigid metal conduit.
 2. Other conduit systems - same material as the conduit with which they are installed.
- H. Bushings:
1. 1-1/4 in. and smaller - high-impact thermosetting phenolic insulation, 150°C, O-Z/Gedney Type A.
 2. 1-1/2 in. and larger - hot-dipped galvanized with thermosetting phenolic insulation, 150°C, O-Z/Gedney Type B.
- I. Locknuts:
1. 1-1/4 in. and smaller - zinc-plated heavy stock steel, O-Z/Gedney.
 2. 1-1/2 in. and larger - cadmium-plated malleable iron, O-Z/Gedney.
- J. Hubs: Cadmium-plated malleable iron, tapered threads, neoprene 'O' ring, insulated throat, O-Z/Gedney.
- K. EMT Connectors: Compression type, zinc-plated steel body, cadmium-plated malleable iron nut, insulated throat, O-Z/Gedney.
- L. EMT Couplings: Compression type, zinc-plated steel body, O-Z/Gedney.
- M. Liquid tight Conduit Connectors: Cadmium-plated malleable iron body and nut, cadmium plated steel ferrule, insulated throat, integrally-cast external ground lug, O-Z/Gedney Type 4QL.
- N. Through-Wall and Floor Seals: Malleable iron body, oversize sleeves, sealing rings, pressure clamps and hex-head cap screws, O-Z/Gedney Type FSK.
- O. End Bells: Hot-dipped galvanized, threaded, malleable iron, O-Z/Gedney Type TNS.
- P. Expansion Fittings: Hot-dipped galvanized, malleable iron with bonding jumpers.
1. Linear - O-Z/Gedney Type AX or TX.
 2. Linear with deflection - O-Z/Gedney Type AXDX.
- Q. Escutcheons: Chrome-plated sectional floor and ceiling plates, Crane No. 10.
- R. Accessories: Reducers, bushings, washers, etc., shall be cadmium-plated, malleable iron of the forms and dimensions best suited for the application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Size conduits as indicated on the Contract Drawings and as required by the National Electrical Code for the quantity and sizes of wires to be installed in the conduit. Do not use conduit sized less than 1/2 in. unless specified otherwise.

- B. No more than one, three-phase circuit or three, single phase circuits may be placed in a single conduit, unless specifically noted on the drawings as such.
- C. Conceal conduits from view in all areas except mechanical and electrical rooms and crawl spaces. Should it appear necessary to expose any conduit:
 - 1. Bring it to the attention of the Engineer immediately and obtain Engineer's approval for location of exposed conduit.
 - 2. Rearrange the work to facilitate an approved installation.
- D. Install conduits at elevations to maintain headroom and at locations to avoid interference with other work requiring grading of piping, the structure, finished ceiling, walls, access panels, etc. Avoid crossing other work.
- E. To prevent displacement, securely support conduits to be concealed in the building structure and installed in advance of other work. Carefully lay out conduits installed within the structure, such as floors, beams, and walls to avoid densities excessive for the construction.
- F. Install conduits imbedded in structural slabs in the middle of the slab below the top and above the bottom reinforcing steel. Maintain a minimum 1-1/2 in. concrete cover except where penetration into the slab is made. Do not install conduit larger than 1 in. in slabs.
- G. Ream, remove burrs, and swab inside conduits before pulling in conductors.
- H. Cap or plug conduits with standard manufactured accessories as soon as the conduits have been permanently installed in place.
- I. Make bends and offsets in 1 in. and smaller conduits with approved bending devices. Do not install conduits, which have had their walls crushed, deformed or their surface finish damaged due to bending.
- J. Where space conditions prohibit the use of standard ells, elbows, and conduits, use cast ferrous alloy fittings of such forms and dimensions as best suited for the application.
- K. Make conduit joints mechanically tight, electrically continuous, and watertight. Pitch conduits in areas where moisture may subsequently be present in a manner to avoid creating moisture traps; where unavoidable, provide junction box with drain fitting at conduit low point.
- L. Install insulated throat threaded hubs on conduits entering enclosures without threaded hubs in wet and damp locations.
- M. Install and neatly rack exposed conduits parallel with and perpendicular to building walls. Provide space for 25% additional conduit. Do not install exposed diagonal conduit runs.
- N. Route and suspend conduits crossing expansion joints to permit expansion, contraction, and deflection utilizing approved fittings to prevent damage to the building, conduits, and supporting devices.
- O. Do not install conduits exposed on the roof unless approval is obtained prior to installation.

- P. Route conduit through roof openings for piping and duct-work where possible; otherwise, route through roof penetration system as specified in Section 26 05 27 - SEALING OF PENETRATIONS.
- Q. Do not place conduits in close proximity to equipment, systems and service lines, such as hot water supply and return lines, steam pipes, which could be detrimental to the conduit and its contents. Maintain a minimum of 3 in. separation, except in crossing, which shall be a minimum 1 in.
- R. Connect motors, equipment containing motors, equipment mounted on isolated foundations, transformers and other equipment and devices which are subject to vibration and which require adjustment, with flexible metallic conduit from the device to the conduit serving it. Restrict length of flexible conduit to 6 ft. maximum unless specifically instructed in writing otherwise by the Engineer. Provide secure supports at the points of attachment on each side of the connection. Use bonding jumpers as directed by the National Electrical Code and other sections of these specifications.
- S. Install escutcheons on sight exposed conduits passing through interior floors, walls, and ceilings in finished spaces
- T. Install fire seals on conduits passing through fire-rated partitions, floors and ceiling.
- U. Install through-wall seals on conduits passing through exterior walls or use standard galvanized steel pipe sleeves, diameters 1/2 in. greater than the outside diameter of the sleeved conduit and fill the annular space with mastic.
- V. Install sleeves for conduits passing through interior floors.
- W. Install insulated throat grounding bushings on conduits stubbed through slabs and foundations into electrical enclosures.
- X. Provide grounding of conduits, fittings and accessories. Refer to grounding section of specifications.
- Y. Feeder Circuits:
 - 1. Install rigid metal conduit in damp and wet locations, in concrete slabs, and where exposed in mechanical and electrical equipment rooms and crawl spaces.
 - 2. Install flexible metal conduit where specified above and where permitted by the authorities having jurisdiction. Use liquid tight flexible metal conduit in damp and wet locations, where exposed in mechanical and electrical equipment rooms, and in kitchen and shop areas.
 - 3. Exterior to the building and above grade, use rigid steel conduit and for elbows and bends greater than 30 degrees.
- Z. Branch Circuits:
 - 1. Install rigid metal conduit in damp and wet locations, in concrete slabs, and where exposed in crawl space.
 - 2. Install electrical metallic tubing where concealed by building structure and where exposed in mechanical and electrical equipment rooms.

3. Exterior to the building and above grade, use rigid steel conduit and for elbows and bends greater than 30 degrees.
4. Install flexible metal conduit where specified above and where permitted by the authorities having jurisdiction. Use liquid tight flexible metal conduit in damp and wet locations, where exposed in mechanical and electrical equipment rooms, and in kitchen and shop areas. Limit flexible conduit to a length of 6 ft. maximum unless specifically instructed otherwise, in writing, by the Engineer.

END OF SECTION

SECTION 26 05 34

OUTLET BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Provide labor, materials, services, equipment and appliances required in conjunction with the installation of outlet boxes as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, with 1/2 in. male fixture studs where required.
- B. Cast Boxes: Cast metal, deep type, gasketed cover, threaded hubs. Use cast boxes for damp and outdoor installation.
- C. Provide boxes with plaster ring where required. Boxes for installation in masonry walls shall be special square corner masonry type.
- D. Furnish boxes with proper covers and device plates.
- E. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain tight. Cast metal box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 - EXECUTION

3.1 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on the Drawings, and as required for splices, taps, wire pulling, equipment connections and code compliance.
- B. Determine from dimensions shown on the Contract Documents and by actual measurements on the site, the exact location of each outlet. Outlet locations shall be modified from those shown on the plans to accommodate changes in door swings, space changes or to clear other interferences that arise or from job modifications. Make such modifications at no cost to the Owner as a matter of job coordination. Coordinate job conditions and notify the Engineer of discrepancies before proceeding with the installation of the work. Set wall boxes in advance of wall construction blocked in place, and secure.

Set wall boxes flush with the finish. Install extension sleeves as required to extend boxes to finished surfaces.

- C. The locations of equipment and outlets shown on the Contract Documents are approximate. Check and verify exact locations in the field. Coordinate installation with the Engineer and with the work under other divisions of the specifications.
- D. Unless otherwise noted, location of outlet boxes, measured to centerline of box, shall be as follows:

EQUIPMENT OR OUTLETS	ELEVATION (ABOVE FINISHED FLOOR)
Toggle Switches	3 feet - 10 inches
Fire Alarm Pull Stations	3 feet - 10 inches
Receptacles	1 foot - 6 inches
Clock and Clock Outlets	7 feet - 6 inches
Fire Alarm Audible or Audible/Visual Devices	6 feet - 8 inches to bottom of device
Combination motor starters	5 feet - 0 inches
Control stations	3 feet - 10 inches
Manual starters	5 feet - 0 inches
Thermostats in office	3 feet - 10 inches
Telephone/data outlets	1 foot - 6 inches
Circuit protective devices	6 feet - 6 inches to top of enclosure

- E. Locate and install boxes to allow access. Where installation is inaccessible, coordinate locations and sizes of required access doors in accordance with other sections of the specifications.
- F. Locate and install to maintain headroom and to present a neat appearance.

3.2 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls. Provide a minimum 6 in. separation in common wall cavity, except provide minimum 24 in. separation in acoustic rated walls. Refer to architectural drawings for locations of acoustic walls.
- B. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- C. Provide knockout closures for unused openings.
- D. Use multiple-gang boxes where multiple devices are shown to be installed together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- E. Install boxes in walls without damaging wall insulation.
- F. Coordinate mounting heights and locations of outlets mounted above counters, benches and back splashes.
- G. Position outlets to coordinate luminaire locations with ceilings.

- H. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
- I. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- J. Align wall-mounted outlet boxes for switches, thermostats and similar devices.

END OF SECTION

SECTION 26 22 13

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Furnish all labor, materials, services, equipment and appliances required in conjunction with the installation of dry type transformers as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturers' specifications for products used.

PART 2 - PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

- A. Description: NEMA ST 20, factory-assembled, air-cooled dry type transformers ratings as indicated on drawings.
- B. Transformers shall meet or exceed the efficiency levels specified in NEMA TP-1, DOE 2016.
- C. Primary Voltage: 480 volts, 3-phase, 3 wire, delta.
- D. Secondary Voltage: 208Y/120 volts, 3 phase, 4 wire, wye.
- E. Insulation system and average winding temperature rise for rated kVA as follows:
 - 1. 1-15 kVA: Class 185 with 150°C rise.
 - 2. 16-500 kVA: Class 220 with 150°C rise.
- F. Case temperature: Do not exceed 50°C rise above ambient 40°C at warmest point at full load.
- G. Winding Taps:
 - 1. Transformers 15 kVA or Less: Two 5 percent below rated voltage, full capacity taps on primary winding.
 - 2. Transformers 30 kVA and Larger: Two each 2-1/2 percent full capacity above and four each 2-1/2 percent fully capacity below primary voltage.
- H. Sound Levels: NEMA ST 20. Maximum sound levels are as follows:
 - 1. 1-9 kVA: 40 dB.
 - 2. 10-50 kVA: 45 dB.

3. 51-150 kVA: 50 dB.
 4. 151-300 kVA: 55 dB.
 5. 301-500 kVA: 60 dB.
- I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
 - J. Mounting:
 1. 1-15 kVA: Suitable for wall or floor mounting.
 2. 16-75 kVA: Suitable for floor mounting.
 3. Larger than 75 kVA: Suitable for floor mounting.
 - K. Coil Conductors: Continuous windings with terminations brazed or welded.
 - L. Enclosure: NEMA ST 20, Type 1 ventilated. Provide lifting eyes or brackets.
 - M. Isolate core and coil from enclosure using vibration-absorbing mounts.
 - N. Nameplate: Include transformer connection data.
 - O. Approved manufacturers: Eaton (Cutler Hammer), General Electric (ABB), Siemens, or Square D. Transformers shall be of the same manufacturer as the panelboards.

PART 3 - EXECUTION

3.1 VOLTAGE ADJUSTMENT

- A. When final connection has been made, check secondary voltage at dry type transformers and make tap adjustments required to obtain correct voltage.

3.2 VIBRATION ISOLATION

- A. Provide isolation procedures described below in addition to those provided by the transformer manufacturer:
 1. For floor or roof transformer installation, use pad type vibration isolators, Korfund Elasto-Grip, waffle, or equal, sized to load 50 pounds per square in. Install one at each corner of the transformer.
 2. For wall-hung transformer installations, use pad type vibration isolators, Korfund Elasto-Grip, waffle, or equal, sized to load 50 pounds per square in. Locate pads between hanger and wall.

3.3 CONNECTIONS

- A. Provide solderless lug bonding connection on the inside of the transformer enclosure in accordance with NEC.

- B. Make primary and secondary connections with liquid tight flexible metal conduit to prevent transformer vibration from being transferred to the building structure or conduit system.

3.4 COORDINATION

- A. Coordinate the work under this section with the work under other divisions of the specifications.

3.5 HOUSEKEEPING PAD

- A. Provide concrete pad for floor-mounted transformers. Concrete work shall be in accordance with other divisions of the specifications. Concrete pad shall be in accordance with Section 26 05 10.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Refer to Section 26 28 16 - OVERCURRENT PROTECTIVE DEVICES.
- C. Furnish all labor, materials, services, equipment and appliances required in conjunction with the installation of panelboards as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturers' specifications for products used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Panelboards shall consist of a box, front, interior and circuit protective devices and shall be manufactured in accordance with NEMA standards and bear applicable UL labels.
- B. The box shall be fabricated of code gauge galvanized sheet steel in accordance with UL standards, and shall have turned edges around the front for rigidity and for clamping on front. Provide standard knockouts on panel enclosure. Fabricate the front from sheet steel and finish with baked on gray enamel over a rust inhibitor. Each front shall have a door mounted on semi-concealed hinges with a cylinder lock, index card and cardholder. For dry indoor installation cover shall be door in door type (hinged door and continuous hinged cover). All panelboard locks shall be master keyed and all index cards shall be properly completed on a typewriter. Furnish two keys for each panelboard.
- C. The interiors shall consist of a factory-assembled rigid frame supporting the rectangular bus, the mains and the neutral bar. The busing shall be arranged for sequence phasing throughout. Bus bar shall be sized to limit the temperature rise in accordance with NEMA standards. The insulated neutral bar shall be located at the opposite end of the structure from the mains. Panelboards shall have either solderless lugs or a main circuit protective device as scheduled. Each enclosure shall be provided with grounding lugs and uninsulated equipment grounding terminals.
- D. Busing shall be tin plated aluminum attached for sequence phasing throughout.
- E. Panelboards shall be single-phase, three wire or three-phase, four-wire as scheduled or as required. Panelboards shall contain sequence style busing and full capacity neutral, composed of an assembly of bolt-in-place molded case automatic air circuit breakers with thermal and magnetic trip and trip free position separate from either "on" and "off" positions. Provide circuit breakers that simultaneously open all poles on double and three-pole circuit breakers. Provide panelboard and circuit breaker interrupting capacities and ratings equivalent to or greater than the fault current available to each panelboard and

as shown on the Drawings. Series rating shall not be used in determining interrupting rating of panelboards. Single-pole circuit breakers serving fluorescent lighting loads shall carry the SWD marking. Circuit breakers serving high intensity discharge lighting loads shall carry the HID marking.

- F. Where required by local or national code, ordinance or other authority, provide NEMA 3R enclosures where located in rooms with fire protection sprinklers. Further, if required by local or national code, ordinance or other authority, provide shields from sprinklers in working clearance in front of panelboards where panelboards are in rooms with fire protection sprinklers. Shields shall be constructed with same gauge metal as panelboard enclosure and shall have the same finish as panelboard enclosure.
- G. Voltage rating, phase, number of wires and ampere rating shall be as shown and scheduled in the Contract Documents.
- H. Approved manufacturers: Eaton (Cutler Hammer), General Electric (ABB), Siemens, or Square D.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install a panelboard at each location shown on the Drawings.
- B. Each panel shall have a circuit index located on the inside of the cabinet door. This index shall have each circuit identified, including spares and spaces. The identification index shall be typewritten and covered with a plastic cover.
- C. The various branch circuits served from the panelboards vary in loading. Carefully balance the load on each phase when connecting the various branch circuits in each panelboard. When all load is turned on and the system is operating a 100 percent demand, the initial unbalance shall not exceed 10 percent.
- D. Refer to Section 26 27 16 regarding spare conduit requirements at flush-mounted panelboard cabinets and additional cabinet requirements.
- E. Refer to Section 26 05 10 regarding labeling requirements for panelboards.
- F. Coordinate the work under this section with the work under other divisions of the specifications.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Provide labor, materials, services, equipment and appliances required in conjunction with the installation of wiring devices as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used. Manufacturer's catalog numbers listed are used to set the standard.
- B. Acceptable Manufacturers: Hubbell, Leviton and Pass & Seymour. All wiring devices for the project shall be of one manufacturer.

PART 2 - PRODUCTS

2.1 SWITCHES

- A. Single pole, 20 amp
 - 1. Hubbell HBL1221; Leviton 1221-2; Pass & Seymour PS20AC1
- B. Double pole, 20 amp
 - 1. Hubbell HBL1222; Leviton 1222-2; Pass & Seymour PS20AC2
- C. Provide 20 amp switches for loads exceeding 10 amps.
- D. Use HP rated switches approved for motor control or disconnect service when controlling or disconnecting motor loads in excess of 1/4 HP.

2.2 WALL BOX PRESET DIMMERS

- A. Provide Leviton "Renoir II" Series dimmers with linear slide and on/off switch or equivalent, sized for 150 percent of the load, unless larger size is indicated. Provide LED, incandescent, fluorescent, or low voltage type dimmer to match the load application shown on the drawings. Provide single-pole or three-way dimmers as indicated on plans. Provide gang dimmers as required in accordance with manufacturer's directions. Provide dimmers with white plastic coverplate.

2.3 RECEPTACLES

- A. Duplex receptacle, 20 amp
 - 1. Hubbell HBL5362; Leviton 5362; Pass & Seymour PS5362

- B. Ground fault circuit interrupting (GFCI), tamper resistant, type receptacle, equivalent to Hubbell GFST83W. Provide weather resistant GFCI receptacle for exterior locations. Do not use feed-through feature. Install GFCI device at each location.
- C. Use 20-amp receptacle when only one receptacle is on a circuit by itself, or as otherwise noted.

2.4 WIRING DEVICES

- A. All wiring devices shall be white unless otherwise noted. Provide ivory wiring devices for normal power circuits. Provide red wiring devices for emergency power circuits.

2.5 COVERPLATES

- A. Stainless steel equivalent to LEviton type 302/304 Series with cadmium plated screws or provide red, smooth nylon coverplates for devices connected to emergency power circuits.
- B. Exterior - extra heavy duty, die cast aluminum, weatherproof while-in-use cover equivalent to Hubbell WP26E series.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Determine from dimensions shown in the Contract Documents and by actual measurements on the site the exact location of each wiring device. The wiring device locations shall be modified from those shown on the plans to accommodate changes in door swings, space changes or to clear other interferences that arise, or from other job modifications. Make such modifications at no cost to the Owner as a matter of job coordination. Notify the Engineer of discrepancies before proceeding with the installation of the work.

3.2 INSTALLATION OF WIRING DEVICES

- A. Install receptacles and switches only in electrical boxes that are clean, free from excess building materials, debris, etc.
- B. Switches installed at one location shall be ganged together under one coverplate.
- C. Install receptacles for electric water coolers out of sight where possible.

3.3 TESTING

- A. Test wiring devices to insure electrical continuity of grounding then energize circuit to demonstrate compliance with requirements.

END OF SECTION

SECTION 26 28 16

OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Furnish all labor, materials, services, equipment appliances required in conjunction with installation of overcurrent protective devices as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

PART 2 - PRODUCTS

2.1 FUSES

- A. Fuses shall be current-limiting, with 200,000 RMS symmetrical amperes interrupting rating and shall be UL listed. All fuses shall be of same manufacturer.
- B. Fuses 600 amperes and smaller shall be Class RK1, dual element. These fuses shall have separated overload and short-circuit elements. The overload, time-delay element shall be spring activated and utilize a eutectic alloy with a 284-degree F. melting point. The fuse shall hold 500 percent of its rated fuse current for a minimum of 10 seconds, equivalent to Bussmann dual-element LPN-RK (250 volts or less rating) and LPS-RK (600 volts or less rating).
- C. Fuses in motor circuits shall be changed, if necessary, as follows: Fuses for not less than 1.15 service factor motors shall have an ampere rating 125 percent of motor full load current or next higher fuse rating. Fuses for 1.0 service factor motors shall have an ampere rating 115 percent of motor full load current or next higher fuse rating. Use special fusing sizing considerations where motors are subjected to high ambient temperatures, where the motor drives an inertia load causing starting current to be prolonged, where on-off cycles less than 30 minutes, or where special hermetically sealed motors have unusual starting characteristics. When a physically smaller fuse is required in a switch, then the fuse clips must be changed.

2.2 MOLDED CASE CIRCUIT BREAKERS

- A. Molded Case Circuit Breaker Characteristics – General
 - 1. Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
 - 2. Circuit breakers shall have an over center, trip free, toggle operating mechanism which will provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.

3. The circuit breaker handle shall reside in a tripped position between ON and OFF to provide local trip indication. Circuit breaker escutcheon shall be clearly marked ON and OFF in addition to providing International I/O markings.
4. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
5. Circuit breakers shall be equipped with UL Listed electrical accessories as noted in these specifications. Circuit breaker handle accessories shall provide provisions for locking handle in the ON and OFF position.
6. All circuit breakers shall be UL Listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.
7. Circuit breakers shall be equipped with factory installed mechanical lugs. All circuit breakers shall be UL Listed to accept field installable/removable mechanical type lugs (except Square D type Q2, Q2H and Q2-H or equivalent). Lug body shall be bolted in place; snap in design not acceptable. All lugs shall be UL Listed to accept solid (not larger than #8 AWG) and/or stranded copper and aluminum conductors. Lugs shall be suitable for 90°C rated wire, sized according to the 75°C temperature rating in the National Electrical Code. Provide lugs as required to accept feeder conductor sizes and quantities as shown on drawings.
8. All circuit breakers shall be capable of accepting bus connections.
9. Circuit breakers shall be fully rated and capable of interrupting the fault current available to them. Series connected ratings with upstream devices is not acceptable to meet this requirement.

B. Thermal-Magnetic Circuit Breakers

1. Circuit breakers shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.
2. Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 40°C ambient temperature.
3. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker except type Square D, Q2, Q2H and Q2-H or equivalent.
4. Standard two- and three-pole circuit breakers up to 250 amperes at 600 VAC shall be UL Listed as HACR type.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install overcurrent devices in accordance with the National Electrical Code. Coordinate the work under this section with the work under other divisions of the specifications.
- B. Do not share neutral conductors between circuits protected by arc fault circuit interrupters.
- C. Fuses shall be installed in all switches as scheduled or noted on the Drawings, and shall be Bussman, Mersen, Littelfuse, Inc., or an approved equivalent.

- D. Unless otherwise indicated, protective devices shall be mounted with top of cabinet or enclosure 6 ft. 6 in. above finished floor, properly aligned, and adequately supported independently of the connecting raceways. All steel shapes, etc., necessary for the support of the equipment shall be furnished and installed where the building structure is not suitable for mounting the equipment directly thereon.
- E. Circuit breaker pick-up level and time delay settings shall be adjusted to values indicated on the drawings.

END OF SECTION

SECTION 26 28 17

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Furnish all labor, materials, services, equipment and appliances required in conjunction with installation of disconnect switches as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Furnish fusible Class 'R' or non-fusible disconnect switches of ampere rating as required, or as indicated on the Drawings. Furnish heavy-duty, quick-make, quick-break, three-phase, three-pole switches, unless otherwise noted. Use NEMA 1 enclosures where installed indoors. Use NEMA 3R for outdoor enclosures. Provide enclosures with interlocking covers, externally front operated flange mounted switch levers, and provisions for use of three safety padlocks in the 'Off' position. Provide horsepower rated switches for motor circuits. Disconnect switches shall be of the same manufacturer as the panelboards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK paragraph: Identification of Electrical Equipment.
- B. Install switches to comply with National Electrical Code and coordinate the work with the work under other divisions of the specifications.

END OF SECTION

SECTION 26 29 13

MOTORS, MOTOR STARTERS AND CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Furnish all labor, materials, services, equipment and appliances required in conjunction with installation of motors, motor starters and controls as indicated in the Contract Documents.

1.2 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

1.3 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

- A. Electrical wiring for mechanical equipment is separated into two main wiring Divisions: "Power Wiring" and "Control Wiring".
- B. Power wiring is wiring and conduit from the primary energy source and includes circuit protective devices, motor starters or controllers, conduit, wiring and safety disconnects beginning at the power supply and terminating at the motor terminals on equipment.
- C. Control wiring is wiring and conduit not included in "Power Wiring", including automatic temperature control wiring, interlock wiring, pilot light, signal wiring, etc., that is included for proper operation or safety of the equipment.
- D. Provide power wiring under Division 26 of this specification.
- E. Control wiring will be provided under Division 23 of this specification.
- F. Refer to Section 26 05 12 - MECHANICAL AND ELECTRICAL COORDINATION, for directions concerning coordination of the work between Divisions 23 and 26. Coordinate the work under this section with the work under other divisions of the specifications.
- G. Install power and control wiring in compliance with National Electrical Code and this Division.
- H. Disconnect switches, except where furnished factory mounted, shall be supplied and installed by the Electrical Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Unless otherwise specified or required, control conductors with a potential of 120 volts or higher shall be a minimum of #14 THWN stranded, and control conductors with a potential of less than 120 volts may be #16 TFFN, unless larger conductors are required to compensate for voltage drop.
- B. Install control wiring in a separate conduit raceway system.
- C. Color code conductors to coordinate with wiring schematics and diagrams.
- D. Other materials shall be as specified in other sections of the specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Note that the electrical design and drawings are based upon equipment furnished under other divisions of the specifications as indicated in the Contract Documents. Should any equipment change dictate changes to the electrical design the required changes shall be made at no additional cost to the Owner.
- B. Verify the electrical capacities of all motors and electrical equipment furnished by other Divisions and install wiring and equipment as required to completely connect all equipment.
- C. Where possible, terminate conduits in conduit boxes on motors. Where motors are not provided with conduit boxes, terminate the conduits in conduit fittings at the motors.
- D. Where disconnect switches are not provided integral with the control equipment for motors, provide disconnect switches required by these Specifications and the NEC. Generally, disconnect switches shall be heavy-duty, enclosed, externally operable, horsepower-rated switches. Each disconnect switch shall be installed where shown on the Drawings or as close as possible to the motor. Each disconnect switch shall be within sight of its associated controller.

3.2 OVERCURRENT PROTECTION

- A. Prior to providing power to equipment, obtain manufacturer's engineering and electrical data.
- B. Provide overcurrent protection of equipment in strict accordance with manufacturer's maximum recommendations and specifications. Provide HACR circuit breakers and fuses in accordance with manufacturer's recommendations and specifications.
- C. Install wiring in a separate conduit raceway system in harmony with other raceway systems on the project.
- D. Install starters, not furnished within a motor control center on a 3/4 in. thick marine plywood backboard painted to match the surrounding area. Apply a minimum of two coats of paint.

Install control and/or accessory devices on the backboard also, in mechanical equipment areas.

3.3 ELECTRICAL CONNECTIONS

- A. Provide electrical connections to each item of equipment requiring such connections.

3.4 EQUIPMENT IDENTIFICATION

- A. Identify starters, switches, pushbuttons and other control devices by the attachment of nameplates constructed from laminated phenolic engraved plastic three-ply with black surface and white interior core at least 1/16 in. thick. Engraved lettering shall use an Arial bold font at least 1/4 in. high and properly spaced for legible and easy reading. Attach plates to equipment with chromium-plated screws. Adhesive attachment is not acceptable.

END OF SECTION