

**BOILER REPLACEMENT
CENTRAL ADMINISTRATION BUILDING**

**BUNCOMBE COUNTY SCHOOLS
ASHEVILLE, NORTH CAROLINA**

DECEMBER 12, 2017

**SUD ASSOCIATES, P.A.
CONSULTING ENGINEERS
ASHEVILLE, NORTH CAROLINA
License No. C-0315**

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DIVISION 01

GENERAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings, Notice to Bidders and Standard General Conditions of the Construction Contract, including Supplementary General Conditions and Division-1 and Division 23 Specification sections, apply to work of this section.

1.02 PROJECT/WORK IDENTIFICATION

- A. General: Project name is "Request for Proposals for Boiler Replacement for Central Administration Building, Buncombe County Schools, Asheville North Carolina", as shown on the Contract Documents prepared by Sud Associates, P.A. which include Drawings and Specifications.
- B. Contract Documents: Indicate the work of the Contract and related requirements and conditions that have an impact on the project. Related requirements and conditions that are indicated on the Contract Documents include, but are not necessarily limited to, the following:
 - 1. Existing site conditions and restrictions on use of the site.
 - 2. Work to be performed concurrently by others.

1.03 SCOPE

- A. A summary of the Scope of Work of this project is given at the end of this section.
- B. Drawings, specifications and equipment schedules are complementary and must be so construed to determine the full scope of work.
- C. Summary by References: Work of the Contract can be summarized by references to the Contract, General Conditions, Supplementary Conditions, Specification Sections, Drawings, addenda and modifications to the contract documents issued subsequent to the initial printing of this project manual and including, but not necessarily limited to, printed material referenced by any of these. It is recognized that work of the Contract is also unavoidably affected or influenced by governing regulations, natural phenomenon including weather conditions and other forces outside the contract documents.

1.04 DISCREPANCIES IN DRAWINGS AND SPECIFICATIONS

Should the Contractor find discrepancies or ambiguities in, or omissions from, the Drawings, Specifications or Equipment Schedules, or should he be in doubt as to their meaning, he shall at once notify the Engineer, who will issue an interpretation. In the case of a discrepancy between the drawings and the specifications, the most stringent condition shall apply.

1.05 ALTERATIONS AND COORDINATION

- A. General: The work of this Contract includes coordination of the entire work of the project, including preparation of general coordination drawings, diagrams and schedules, and control of site utilization, from beginning of construction activity through project closeout and warranty periods.

- B. Electrical Requirements: Except as otherwise indicated, comply with applicable provisions of The National Electrical Code (NEC) and standards by National Electrical Manufacturer's Association (NEMA), for electrical components of general work.
- C. Provide Underwriters Laboratories listed and labeled products where applicable.

1.06 COMPLIANCE WITH FEDERAL AND STATE LAWS AND REGULATIONS

- A. General: Contractor including his subcontractors shall comply with all applicable federal, state and local laws and regulations.
- B. Administrative Requirements: The Contractor shall provide any documents required to comply with administrative and legal requirements. These include summary reports of sales tax and other assessments, as requested by the Owner, etc.

1.07 EXAMINATION OF PREMISES

- A. Each Bidder prior to submitting a proposal shall examine the site and all conditions thereon. All proposals will be presumed to include all such existing conditions as may affect any work of this project; and failure to familiarize himself with any such conditions will in no way relieve the successful bidder from the necessity of furnishing all materials or performing any work that may be required to complete the work in accordance with the drawings and specifications, without additional cost to the Owner. Examination of premises shall be scheduled, by prior appointment only, with:

Mr. Al Meskil
HVAC Supervisor
Buncombe County Schools
175 Bingham Road
Asheville, North Carolina 28806
Telephone: 828/ 775-2086

1.08 CORRESPONDENCE TO THE OWNER AND ENGINEER

- A. All papers required to be delivered to the Owner shall, unless otherwise directed in writing to the Contractor, be delivered to Sud Associates, P.A., 20 Battery Park, Suite 706, Asheville, North Carolina, 28801. Copies of correspondence to the Engineer shall be sent to the Owner, in care of Mr. Al Meskil, address listed above.

1.09 THE CONTRACT DOCUMENTS

- A. The Contract Documents consist of Notice to Bidders, General Conditions, Supplementary General Conditions, all sections of Division 1, all sections of Division 23, the Drawings, Specifications and Equipment Schedules, including all bulletins, addenda, or other modifications of the Drawings and Specifications incorporated into the documents prior to their execution, the Proposal and Contract Form, supporting information submitted by the Contractor, and Insurance Certificates evidencing the needed coverages. All of these items together form the Contract Documents.
- B. The contract will be awarded to the lowest responsible bidder for the entire work covered under this contract. Prior to contract award, the Contractor will be required to provide cost breakdowns requested by the Owner or other information on their bid and any documents required to comply with legal and/or administrative requirements. Summary reports of sales tax and other assessments, as requested by the Owner, shall also be provided.

PART 2 PRODUCTS (Not applicable)

PART 3 EXECUTION (Not applicable)

END OF SECTION 01 01 00

**REQUEST FOR PROPOSAL TO FURNISH CONDENSING BOILERS
CENTRAL ADMINISTRATION BUILDING**

BUNCOMBE COUNTY SCHOOLS

SCOPE OF WORK

This project furnishes three (3), 1.5 million BTU, condensing boilers for Buncombe County Schools - Central Administration Building. The equipment and quantities shall be in compliance with the specifications and the equipment schedules. It is the bidder's responsibility to thoroughly examine the specifications and schedules and include all items that are required to be furnished by the manufacturer.

The boilers are expected to have a delivery time of **four (4)** weeks. The objective is to bid them directly to the manufacturers and place an order. While the boilers are being delivered, the rest of the work will be bid and initiated so that the boilers can be installed when they arrive.

The quoted price shall include shipping to the site, or any other location in Asheville as specified by the Installing Contractor. The boilers shall be delivered within **four (4)** weeks of Notice to Proceed by Buncombe County Schools.

The Scope of Work includes furnishing all equipment indicated or implied by the specifications and equipment schedules. The Scope of Work includes, but is not limited to the following:

Mechanical Equipment:

1. Delivery, startup, owner training, O&M manuals, and manufacturer's warranty of fan coil units, and accessories as provided for in the manufacturer's proposal/submittal and in compliance with the contract documents.
2. Delivery, startup, owner training, O&M manuals, and manufacturer's warranty of three DOAS units, and accessories as provided for in the manufacturer's proposal/submittal and in compliance with the contract documents. Accessories shall include adjustable frequency drives for the fans.
3. **Alternate Bid** - Mechanical Equipment:
 - A. Owner Preferred Alternate 1– Furnish Three (3), 1.5 million BTU, Crest Condensing Boilers manufactured by Lochinvar, No Exceptions.

PART 1 - GENERAL

1.01 GENERAL

- A. All work under this heading is subject to all Contract Documents, and includes the furnishing of all labor, materials, equipment, accessories, etc. for the complete installation of all Alternates as outlined in this Specification Section.

PART 2 – ALTERNATES

2.01 ALTERNATES

- A. Alternate 1 – Install new motors and variable speed drives for hot water pumps P-3 and P-4.

END OF SECTION 01 75 00

DIVISION 23
MECHANICAL

SECTION 23 05 10
BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 REFERENCES & INTENT

- A. All work of this Division shall comply with the requirements of the Drawings, General Conditions, Supplementary General Conditions and Division 01 Specifications section.
- B. Study all drawings and specifications before submitting bids.
- C. Work under this Division includes all essential labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items for proper installation and operation of all systems even though not specifically mentioned or indicated.
- D. Drawings are diagrammatic. Drawings are not intended to be absolutely precise and do not specify or show every offset, fitting, and component. The purpose of the drawings is to indicate a system concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational. Contractor shall route piping or provide offsets to avoid interference with structural elements, equipment, electrical panels and junction boxes, etc. Verify locations, dimensions, flow directions, etc. before construction.
- E. It is the intent of these specifications and drawings to provide for finished systems of the quality specified, properly tested, balanced and ready for operation. This includes all devices and accessories required to make the work complete even though such items may not be expressly shown or specified. Drawings and specifications are complementary and must be so construed to determine the full scope of work.
- F. Jobsite Conditions: The Contractor shall visit the site and familiarize himself with the existing conditions before submitting his bid. Failure to do so does not relieve the Contractor from completing the work as specified herein and after. Requests for additional payments due to the Contractor's failure to allow for work conditions will be rejected.

1.02 WORK INCLUDED

- A. The following work is specifically included without limiting the generality implied by these specifications and drawings.
 - 1. All mechanical scope of work specified herein and as shown on the plans. Contractor should review all drawings and include all items that are a part of his scope.
 - 2. All associated wiring, cutting and patching.
- B. Bidders shall examine equipment plans and specifications and include in their bids all labor and material required for complete installation and connection of equipment which is properly a part of their trade even if it is not provided in the equipment specifications.

1.03 STANDARDS AND CODES

- A. All equipment with electrical components shall bear the UL label.
- B. The following minimum standards apply wherever applicable:
 - ANSI American National Standards
 - ASTM American Society for Testing Materials
 - NBFU National Board of Fire Underwriters
 - NEC National Electric Code
 - NEMA National Electrical Manufacturers Association
 - NFPA National Fire Protection Association
 - OSHA Occupational Safety and Health Act
 - SMACNA Sheet Metal & Air Conditioning Contractors National Association, Incorporated
 - North Carolina Building Code
 - Any Other Applicable local and State Codes
- C. In the event there are conflicts between specifications and standards or codes, standards or codes shall govern unless specifications are in excess of standards.

1.04 PERMITS AND FEE

- A. Make application for all necessary permits and pay applicable fees.

1.05 STRUCTURAL STEEL AND CONCRETE

- A. Structural members may not be pierced without prior written approval of the Engineer.

1.06 WATERPROOFING

- A. Waterproofed floors and walls may not be cut.

1.07 WORK SCHEDULE

- A. Work schedule shall be in accordance with Division 01.
- B. Any demolition or installation work producing excessive dust or noise deemed to be disruptive or possibly unsafe to building operations must be, at the Owner's discretion, performed after normal working hours.

1.08 PROTECTION OF EQUIPMENT

- A. Provide all necessary protection and be fully responsible for material and equipment stored or installed on the site. Material or equipment stolen or damaged shall be replaced at no additional cost to the Owner.
- B. Provide protection against theft, physical damage and the entry of dirt, water or corrosive fumes into the material and equipment. Maintain protective covers for the duration of construction. Store equipment, such as controls, subject to damage by moisture and temperature extremes in a dry, heated space.

1.09 FIRE SAFETY

- A. Fire Watch: Provide a fire watch wherever welding, brazing, cutting or other processes involving an open flame or potential for generating sparks is used. Fire watch shall consist of a person with a 10 pound carbon dioxide fire extinguisher. While on fire watch, the person so assigned shall have no other duties or assignments.

- B. Fire Blanket: In addition to providing a fire watch, use an approved fire blanket to cover any combustible materials in the immediate area.

1.10 GUARANTEES

- A. Furnish written guarantee in accordance with requirements of General Conditions. Partial approval of a portion of work does not affect the validity of guarantee.

1.11 SHOP DRAWINGS

- A. It shall be noted that shop drawing submittals processed by the Engineer are not change orders; that the purpose of shop drawing submittals is to demonstrate to the Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. If deviations, discrepancies or conflicts between shop drawing submittals and the contract documents in the form of design drawing and specifications are discovered either prior to or after shop drawing submittals are processed by the Engineer, the design drawings and specifications shall control and shall be followed. The Engineer may also require the contractor to submit samples of proposed or specified equipment for approval with the samples to be returned to the contractor upon request.

- B. Prior to procurement or manufacturing, submit for approval appropriate shop drawings and/or descriptive literature giving performance data, physical size, wiring diagrams, configuration, capacity, material, etc., for all items under this Division including the following:

1. Hydronic Piping & Piping Specialties
2. General Duty Valves for HVAC
3. Variable Speed Drives
4. Mechanical Painting & ID
5. HVAC Insulation
6. DDC Controls, Valves and Actuators

- C. The contractor shall visit the site and familiarize himself with the project requirements and the field conditions before preparing shop drawings and ordering equipment. Field verify the characteristics of all specified or existing equipment before preparing shop drawings. This shall include available space, available voltages, suitability of substrate for receiving the specified equipment, etc. Where existing equipment is re-used, he shall verify dimensions, capacities, horse-power, etc. and bring any discrepancies to the attention of the Engineer.

- D. Where different products have to work together, it is the Contractor's responsibility to select manufacturers whose products are visually and/or technically compatible.

- E. Prepare listing of all equipment and materials for the project. A sample schedule is included at the end of this section to complete this requirement. Provide all information represented.

1.12 RECORD DRAWINGS

- A. During construction, keep an accurate record of all changes and deviations from contract documents. Upon completion of this installation, the contractor shall submit to the Engineer marked up prints indicating any installed work that is different from what is shown on the

drawings. Complete and accurate drawings shall be submitted to the Owner at the conclusion of this project. All changes will be reflected in CAD format. Marked-up as-built drawings will not be permitted.

PART 2 - PRODUCTS

2.01 QUALITY OF MATERIAL

- A. Equipment of the same general type shall be of the same make. Reference is made to relays, motors, valves, motor starters, contactors, etc.
- B. Brand names and catalog numbers included with equipment or material specifications are used to indicate quality, rating or operating characteristics of the equipment or material.
- C. All materials provided shall be new and shall be approved and labeled by the Underwriter's Laboratories, Inc., or other accredited third party agency, wherever such agency has applicable standards. All work shall be accomplished in a neat, workmanlike manner by experienced journeymen. All work shall be performed at such times as are required by the progress of the job.
- D. All components, equipment and systems shall comply with ASHRAE 90.1 and any other applicable ASHRAE standard.

PART 3 - EXECUTION

3.01 CLEARANCE AND RESTORATION OF SITE

- A. It may be required to temporarily remove existing ceiling tiles, piping, duct, conduits, etc. to introduce new work as specified in this Division. Contractor, after installation of new work, shall reinstall, reconnect removed items to match the existing. Installation of any new equipment shall not compromise existing fire ratings of rated assemblies. All penetrations shall be sealed to existing conditions per UL guidelines for penetration protections. Provide offsets if required in existing piping, ducts etc. to introduce new work.

3.02 COORDINATION

- A. Install all work to permit removal of equipment without damage to the equipment or the building. Verify equipment space requirements, condition of substrate, voltages, etc. at the time of shop drawing submission and advise the Engineer of any conflict.
- B. Coordinate equipment locations as well as piping and conduit routing with Owner's representative to optimize all present and foreseen future space usage and clearance requirements.
- C. Do not rough prior to receipt of approved shop drawings.

3.03 EQUIPMENT INSTALLATION AND SUPPORT

- A. Install all equipment where indicated, in accordance with manufacturer's published installation instructions, and with recognized industry practices to ensure that equipment complies with requirements and serves intended purposes. Consult with Engineer if said instructions or practices conflict with the drawings/specifications.
- B. Support plumb, rigid and true to line all work and equipment furnished under this Division.

Study thoroughly architectural, mechanical drawings and all related drawings to determine how equipment, piping, ductwork, etc., are to be supported, mounted or suspended. Provide extra steel bolts, inserts, pipe stands, brackets and accessories for proper support as required whether or not shown on drawings. When directed, furnish for approval a drawing showing supports.

- C. Any system component which may require maintenance, such as control valves, manual valves, strainers, etc. shall not be installed over electrical equipment, machinery, control panels or floor openings.

3.04 FINAL ADJUSTMENT AND TESTING

- A. General: Provide all testing, preliminary and final adjustment of instrumentation for this purpose. Conduct all tests in full compliance with applicable codes prior to covering or concealing work by insulation, enclosures, etc. Material found to be defective shall not be repaired. It shall be replaced with new material which tests satisfactorily. Defective workmanship shall be corrected.
- B. Working Tests: Subject all equipment and controls to simultaneous and continuous working tests for a period of one day prior to final inspection. Make adjustments, repairs and equipment replacements as required.

3.05 LABELS, IDENTIFICATION AND TAGS

- A. All components or equipment shall be identified using 3/4 inch high permanent engraved bakelite nameplates or 3/4 inch high anodized aluminum nameplates, white letter, black background, with minimum 1/4 inch high letters. Nameplates shall be permanently attached with pin-head screws to device or to wall or mounting panel above device. Stick-on type labels will not be acceptable.

3.06 OWNER'S RIGHT TO TEST SYSTEMS

- A. Should, in the opinion of the Engineer, and during the guarantee period, reasonable doubt exist as to the proper functioning of any equipment installed under this Contract, the right is reserved for the Owner and Engineer to perform any test deemed practical to determine whether such equipment is functioning properly and performing at required capacity. If such tests show proper functioning, the cost of the test will be paid by the Owner. If the tests indicate a deficiency in equipment capacity or performance, the Contractor shall pay the cost of the test and also make good any deficiencies shown by the test to the full satisfaction of the Owner and the Engineer.

3.07 CLEANING UP

- A. The contractors performing work under this section shall at all times keep the premises and the building in a neat and orderly condition and any instructions of the Engineer in regard to the storing of material, protective measures, cleaning up of debris, etc. shall be explicitly followed. At the completion of the job, all equipment shall be cleaned to the satisfaction of the Owner.
- B. The building will be occupied during installation of the new addition and/or alterations as described hereinafter. Thus, special care shall be taken during installation to protect equipment and other furniture in the buildings from dust and debris generated during installation of work specified in this Division.

3.08 INSPECTION CERTIFICATES

- A. Obtain all inspections required by law, ordinances, rules, and regulations of the Authorities having jurisdiction and obtain and furnish to the Engineer certificates of such inspections, pay all fees, charges, and other expenses in connection therewith.

3.09 FINAL REVIEW

- A. Final review and tests of the completed construction shall be performed in the presence of the Engineer or his representative and shall be at such times as are convenient to the Engineer. Final tests shall show conclusively that all equipment performs its intended and specified function and that all work complies with the provisions of these specifications. All material, equipment, and instruments required for the tests shall be furnished by the Contractor at his own expense.

3.10 EQUIPMENT DELIVERY AND PROTECTION

- A. All material shall be delivered and unloaded by the Contractor within the project site as directed by the Owner. The Contractor shall protect all material and equipment from breakage, theft or weather damage.

3.11 OPERATING INSTRUCTIONS

- A. The Contractor shall provide a minimum of six (6) hours of personal instruction to Owner's personnel in the proper operation of all equipment specified and provided. The instruction shall be provided by factory trained and certified competent personnel.
- B. Maintenance Manuals shall be submitted in three (3) copies in vinyl 3-ring binders. Each binder shall have the following:
 - 1. Service telephone number of the installing company, including an emergency number.
 - 2. Contact person, phone number, and address of manufacturer or distributor where equipment was purchased.
 - 3. The manufacturing company's operating and maintenance manuals for each piece of equipment.
 - 4. Copies of all approved shop drawings.
- C. Furnish for each building permanent type charts, framed under glass, mounted where directed as follows:
 - 1. Service organizations with day and night telephone numbers.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions, Division-1 Specification section, and other Division 23 sections apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of piping specialties required is indicated on drawings and/or specified in other Division 23 sections, and by requirements of this section.

1.03 SUBMITTALS

- A. **Manufacturer's Data:** Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of piping specialty. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.

PART 2 - PRODUCTS

2.01 PIPE ESCUTCHEONS

- A. **General:** Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. **Pipe Escutcheons for Moist Areas:** For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. **Pipe Escutcheons for Dry Areas:** Provide stamped steel escutcheons, solid or split hinged, 22 gauge minimum.

2.02 DIELECTRIC UNIONS

- A. **General:** Provide brass ball valves where piping material changes from ferrous to non-ferrous material in order to prevent galvanic action and stop corrosion. Non-metallic dielectric unions shall not be used.

2.03 FIRE BARRIER PENETRATION SEALS

- A. Provide seals for any opening through fire-rated walls, floors, or ceilings used as passage for mechanical components such as piping or ductwork in accordance with UL penetration protection guidelines with UL approved components. Refer to fire barrier penetration

detail(s) in construction drawings.

2.04 THERMOMETERS

- A. Provide solar digital thermometers for all water temperature display applications as shown on plans and/or as otherwise required by field conditions.

2.05 THERMOMETER WELLS

- A. Provide thermometer wells constructed of stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

2.06 FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.
- B. Pipe Sleeves: Provide pipe sleeves of one of the following: (except where allowed otherwise in non-load bearing and non-fire barrier partitions).
 - 1. Steel-Pipe: Fabricate from Schedule 40 galvanized or black steel pipe; remove burrs
 - 2. Iron-Pipe: Fabricate from cast-iron or ductile iron pipe; remove burrs.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surfaces.
- B. Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.
- C. Fire Barrier Penetration Seals: Comply with UL guidelines and refer to details in drawings.

3.02 INSTALLATION OF TEMPERATURE GAGE

- A. General: Install temperature gages in vertical upright post, and tilted so as to be easily read by observer standing on floor.
- B. Thermometer Wells: Install in piping tee where indicated, in vertical upright post. Fill well with oil or graphite, secure cap. Install a spare well within twelve inches of each temperature sensor installed under the temperature control section.

3.03 INSTALLATION OF FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest plumbing floor drain or elsewhere as indicated
- B. Pipe Sleeves: Install pipe sleeves where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than pipe run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 1/4" above level floor finish and 3/4" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.
- C. All interior pipe sleeves shall be schedule 40 steel, unless otherwise noted.
- D. Install iron-pipe sleeves at exterior penetrations, both above and below grade.

3.04 ADJUSTING AND CLEANING

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

END OF SECTION

SECTION 23 05 23
GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions, Division-1 Specification sections and other Division 23 specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of valves required is indicated on drawings and/or specified in other Division - 23 sections, and by requirements of this section.

1.03 QUALITY ASSURANCE

- A. Valve Types: Provide valves of same type by same manufacturer.
- B. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

1.04 CODES AND STANDARDS

- A. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions."
- B. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged – or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves."

1.05 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing Manufacturer's figure number, size, location, and valve features for each required valve.

PART 2 - PRODUCTS

2.01 VALVES

- A. General: Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.
- B. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
- C. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn.

Provide lever handle for quarter-turn valves, 6" and smaller, other than plug valves. Provide gear operators for quarter-turn valves 8" and larger. Provide chain-operated sheaves and chains for overhead valves 8" and larger or as indicated.

2.02 GATE VALVES

A. Comply with the following standards:

1. Cast-Iron Valves: MSS SP-7
2. Bronze Valves: MSS SP-80
3. Steel Valves: ANSI B16.34

2.03 GLOBE VALVES

A. Comply with the following standards:

1. Cast-Iron Valves: MSS SP-85
2. Bronze Valves: MSS SP-80
3. Steel Valves: ANSI B16.34

2.04 BALL VALVES

A. Comply with the following standards:

1. Cast-Iron Valves: MSS SP-72
2. Steel Valves: ANSI B16.34

2.05 BUTTERFLY VALVES

A. Comply with MSS SP-67, "lug" type.

2.06 SWING CHECK VALVES

A. Comply with the following standards:

1. Cast-Iron Valves: MSS SP-71
2. Bronze Valves: MSS SP-80
3. Steel Valves: ANSI B16.34

2.07 WAFER CHECK VALVES

A. General: Provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between 2 standard class125 flanges.

2.08 LIFT CHECK VALVES

A. Conform to FCI 74-1 for design, rating and testing.

2.09 VALVE FEATURES

A. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

- B. Bypass: Comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving.
- C. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
- D. Flanged: Valve flanges complying with ANSI B16.5, (steel), or ANSI B16.24 (bronze).
- E. Threaded: Valve ends complying with ANSI B2.1.
- F. Butt-Welding: Valve ends complying with ANSI B16.25.
- G. Socket-Welding: Valve ends complying with ANSI B16.11.
- H. Solder-Joint: Valve ends complying with ANSI B16.18.
- I. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.5 (steel), or ANSI B16.24 (bronze).
- J. Pressure Ratings: Unless indicated otherwise, valve pressure ratings shall be as follows:
- K. Water System: Class 150 for bronze valves, Class 125 for iron valves.
- L. Steam Systems: Bronze gate, check, and globe valves in lines with operating pressures to 150 psi SWP shall be 150-pound class and 200-pound class for higher pressures. Cast iron gate valves in lines with operating pressures to 125 psi SWP shall be 125-pound class and 250-pound class for higher pressures.

NOTE: All piping valves, fittings, and steam specialties furnished under this contract shall be as required for the installation of 150 psi boilers operating between 125 psi and 150 psi SWP. (Refer to Section 15570 and 15571 for additional requirements.).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Except as otherwise indicated, comply with the following requirements:
 - 1. Install valves where required for proper operation of piping and equipment, including valves in branch lines to isolate sections of piping.
 - 2. Locate valves so as to be accessible and so that separate support can be provided when necessary.
 - 3. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable.
 - 4. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
- B. Insulation: Where insulation is indicated, install extended- stem valves, arranged in proper manner to receive insulation.
- C. Mechanical Actuators: Install mechanical actuators with chain operators where indicated. Extend chains to about 5' above floor and hook to clips to clear aisle passage.
- D. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install

valves with the following ends or types of pipe/tube connections:

1. Tube Size 2" and Smaller: Soldered-joint valves.
 2. Pipe Size 2" and Smaller: Threaded valves.
 3. Pipe Size 2-1/2" and Larger: Flanged valves.
- E. Valve Stems: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.
- F. Non Metallic Disc: Shall not be used, except where indicated.
- G. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.
- H. Fluid Control: Except as otherwise indicated, install gate and butterfly valves to comply with ANSI B31.9. Where throttling is indicated or recognized as principal reason for valve, install butterfly valves.

3.02 INSTALLATION OF CHECK VALVES

- A. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.
- B. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow.
- C. Lift Check Valves: Install in piping line with stem vertically upward, position for proper direction of flow.

3.03 VALVE SCHEDULE

- A. Subject to compliance with "Pressure Ratings" required by Page 15100-3 of these specifications.

3.04 GATE VALVES

- A. Refer to Supplementary Valve Schedule for Equivalents.
- B. 2" and Smaller: Class 150, Bronze, screw-in bonnet, rising stem, solid wedge, equivalent to Stockham B-100 for threaded ends or Stockham B-108 for solder ends. Milwaukee 148, Milwaukee 1149 or Grinnel 3010, Grinnel 3010-SJ, respectively.
- C. 2-1/2" and Larger: Class 125, flanged ends, iron body, bolted bonnet, solid wedge, bronze mounted, OS&Y rising stem, equivalent to Stockham G-623.
- D. Hose End, 2-1/2" and smaller: FM, UL-listed, 175 psi, bronze body, solid wedge, inside screw, nonrising stem, equivalent to Jenkins 707.
- E. Threaded End, 2" and smaller: FM, UL-listed, 175 psi, bronze body, solid wedge, outside screw and yoke, rising stem, equivalent to Stockham B-133, Nibco T-1040, or Crane 459.
- F. Flanged End, 2-1/2" and larger: FM, UL-listed, 175 psi, iron body, bronze mounted, solid wedge, outside screw and yoke, rising stem, equivalent to Stockham G-634.

- 3.05 GLOBE VALVES
- A. 2" and Smaller: Class 150, Bronze body, screw-in bonnet, integral seat, renewable disc, equivalent to Jenkins 746 for threaded ends or Jenkins 1200 for solder ends.
 - B. 2-1/2" and Larger: Class 125, flanged ends, iron body, bolted bonnet, renewable seat and disc, bronze mounted, equivalent to Jenkins 613.
- 3.06 DRAIN VALVES
- A. Bronze body, screw-in bonnet, rising stem, composition disc, 3/4" hose outlet, equivalent to NIBCO 73 for threaded ends or NIBCO 72 for solder ends.
- 3.07 PLUG VALVES
- A. 2" and Smaller: 150 psi, bronze body, straightaway pattern, square head, threaded ends, equivalent to Lunkenheimer 454.
 - B. 2-1/2" and Larger: 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends, equivalent to Powell 2201.
- 3.08 BALL VALVES
- A. 1" and Larger: 400 psi WWP, bronze body, full port, bronze trim, TFE seats and seals. Valves shall be CONBRACO "Appollo" series, or equivalent.
- 3.09 BUTTERFLY VALVES
- A. Butterfly Valves shall be full-tapped lug design suitable for dead-end service. Valves through 6" shall have infinite position handles equipped with adjustable memory stops.
 - B. Valves for working pressure up to 150 psi and 275 F shall have cast iron body, ductile iron or aluminum bronze discs, stainless steel shaft, and elastomeric seats and o-rings.
 - C. Valves for working pressure above 150 psi shall have carbon steel body and disc, stainless steel stem, reinforced TFE pressure actuated seat with backing ring, and stuffing box with elastomeric packing, follower, and gland.
 - D. Valves shall be Jamesbury or equivalent.
- 3.10 CHECK VALVES
- A. 2" and Smaller: Class 150, bronze body, horizontal swing, regrind type, Y-pattern, renewable disc, equivalent to Stockham B-319 for threaded ends or Stockham B-309 for solder ends.
 - B. 2-1/2" and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends, equivalent to Stockham G-931.
 - C. 2-1/2" and Larger: Class 175, iron body, bronze mounted, renewable composition disc and bronze seat ring, bolted cover, flanged ends, equivalent to Stockham G-940.
- 3.11 WAFER CHECK VALVES

- A. All Sizes: Cast-iron body, aluminum bronze or plated iron plates, stainless steel stem, Buna-N seat, stainless steel springs, equivalent to Stockham WG-970.

3.12 LIFT CHECK VALVES

- A. 2" and Smaller: Class 150, Bronze body, lift type, spring loaded, renewable disc, threaded ends, equivalent to Jenkins 655A.

3.13 SUPPLEMENTARY VALVE SCHEDULE

- A. General: Provide selections from the following valves for various valve type listed in Division-23 piping sections.

3.14 GATE VALVES

- A. 2" and Smaller: Class 150, bronze, screw-in bonnet, rising stem, solid wedge.

	<u>Threaded Ends</u>	<u>Solder Ends</u>
Fairbanks:	0252	0282
Grinnel:	3010	3010-SJ
Hammond:	IB640	IB635
Jenkins: 47		1242
Lunkenheimer: 2127		2132
Milwaukee:	148	1149
Nibco:	T-111	S111
Powell:	500-S	1821-S
Stockham:	B-100	B-108
Walworth:	55	55-SJ

- B. 2" and Smaller: Class 150, bronze, screw-in bonnet, non-rising stem, solid wedge.

	<u>Threaded Ends</u>	<u>Solder Ends</u>
Fairbanks:	0250	0280
Grinnel:	3000	3000-SJ
Hammond:	IB645	IB647
Jenkins: 370		1240
Lunkenheimer: 2129		2133
Milwaukee:	105	1145
Nibco:	T-113	S113
Powell:	507	1822
Stockham:	B-103	B-104
Walworth:	55	4-SJ

- C. 2-1/2" and Larger: Flanged ends, Class 125, iron body, bolted bonnet, solid wedge, bronze-mounted.

	<u>OS&Y Rising Stem</u>	<u>Non-Rising Stem</u>
Fairbanks:	0405	0403
Grinnel:	6020	6060
Hammond:	IR1140	IR1138
Jenkins: 651C		326
Lunkenheimer: 1430		1428
Milwaukee:	F-2885	F-2882
Nibco:	617	619
Powell:	1793	1787
Stockham:	G-623	G-612

Walworth: 8726-F 8719-F

- D. Hose-End, 2-1/2": FM, UL-listed, 175 WWP, bronze body, solid wedge, inside screw, non-rising stem. Provide cap and chain.
 Fairbanks: 0210
 Jenkins: 707
 Lunkenheimer: 366
 Nibco: T-113-HC
 Walworth: 115
- E. Threaded End, 2" and Smaller: FM, UL-listed, 175 WWP, bronze body, solid wedge, outside screw and yoke, rising stem.
 Crane: 459
 Fairbanks: 0222
 Hammond: IB681
 Jenkins: 275U
 Nibco: T-104-0
 Stockham: B-133
 Walworth: 904
- F. Flanged End, 2-1/2" and Larger: FM, UL-listed, 175 WWP, iron body bronze mounted, solid wedge, outside screw and yoke, rising stem.
 Crane: 467
 Fairbanks: 0412
 Hammond: IR1154
 Jenkins: 825-A
 Nibco: F-607-0
 Stockham: G-634
 Walworth: 8713-F

3.15 BUTTERFLY VALVES

- A. 6" and Smaller: 150 psi, cast-iron body, extended neck, aluminum bronze disc, reinforced resilient EDPM seat, manual lever and lock.
- | | | |
|-----------------------------------|--------------|-------------|
| | <u>Wafer</u> | <u>Lug</u> |
| Fairbanks: | 302 | 502 |
| Grinnell: | WC-8211 | LC-8211 |
| Hammond: | 3804 | 3824 |
| Jamesbury: | 815W | 815L |
| Nibco: | WL-082-3 | NL-082-3 |
| Powell: | Series 1000 | Series 5000 |
| Stockham: | LG-511-BS3E | LG-711-BS3E |
| Grooved Ends: Vitaulic Series 700 | | |
- B. 8" and Larger: 150 psi, cast-iron body, extended neck, aluminum bronze disc, reinforced resilient EDPM seat, gear operator.
- | | | |
|-----------------------------------|--------------|-------------|
| | <u>Wafer</u> | <u>Lug</u> |
| Fairbanks: | 402 | 602 |
| Grinnell: | WC-8212 | LC-8212 |
| Nibco: | WL-082-5 | NL-082-5 |
| Powell: | Series 1000 | Series 5000 |
| Stockham: | LG-521-B@3E | LD-721-BS3E |
| Grooved Ends: Vitaulic Series 701 | | |

CHECK VALVES

- A. 2" and Smaller: Class 150, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc.

	<u>Threaded Ends</u>	<u>Solder Ends</u>
Fairbanks:	0640	0680
Grinnel:	3300	3300-SJ
Hammond:	IB940	IB941
Jenkins:	92-A	1222
Lunkenheimer:	2144	2145
Milwaukee:	509	1509
Nibco:	T-413	S413
Powell:	578	1825
Stockham:	B-319	B-309
Walworth:	3406	3406-SJ

- B. 2-1/2" and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends.

Fairbanks:	0702
Grinnell:	6300
Hammond:	IR1124
Jenkins:	629
Lunkenheimer:	1790
Milwaukee:	F2971
Nibco:	F-918
Powell:	559
Stockham:	G931
Walworth:	8928-F

- C. 2-1/2" and Larger: FM, UL-listed, 175 WWP iron body bronze mounted, renewable composition disc and bronze seat ring, bolted cover, flanged ends.

Fairbanks:	071
Jenkins:	729
Nibco:	F-908-W
Stockham:	G-940
Walworth:	8883-LT

END OF SECTION

SECTION 23 05 29
SUPPORTS, ANCHORS AND VIBRATION ISOLATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions, Division-01 Specification sections, and other Division 23 specification sections apply to work of this section.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Code Compliance: Comply with applicable codes pertaining to product materials and installation of supports and anchors.
 - 2. UL and FM Compliance: Provide products which are UL-listed and FM approved where required.
 - 3. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS) Standard Compliance: 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.
- E. Acceptable Manufacturers: Vibration Mountings and Controls, Inc., Grinnell, Modern, or approved equal.

1.03 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

PART 2 - PRODUCTS

2.01 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 pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
 - 1. Adjustable Steel Clevis Hangers: MSS Type 1.
 - 2. Yoke Type Pipe Clamps: MSS Type 2.
 - 3. Steel Double Bolt Pipe Clamps: MSS Type 3.

4. Steel Pipe Clamps: MSS Type 4.
5. Adjustable Swivel Pipe Rings: MSS Type 6.
6. Adjustable Steel Band Hangers: MSS Type 7.
7. Adjustable Band Hangers: MSS Type 9.
8. Adjustable Swivel Rings, Band Type: MSS Type 10.
9. Split Pipe Rings: MSS Type 11.
10. Extension Split Pipe Clamps: MSS Type 12.
11. U-Bolts: MSS Type 24.
12. Clips: MSS Type 26.
13. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
 - a. Plate: Unguided type.
 - b. Plate: Guided type.
 - c. Plate: Hold-down clamp type.
14. Pipe Saddle Supports: MSS Type 36, including steel pipe base- support and cast-iron floor flange.
15. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.
16. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.
17. Single Pipe Rolls: MSS Type 41.
18. Adjustable Roller Hangers: MSS Type 43.
19. Pipe Roll Stands: MSS Type 44.
20. Adjustable Pipe Roll Stands: MSS Type 46.

2.02 VERTICAL-PIPING CLAMPS

- A. General: Except as otherwise indicated, provide factory- fabricated vertical-piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
 1. Two-Bolt Riser Clamps: MSS Type 8.
 2. Four-Bolt Riser Clamps: MSS Type 42.

2.03 HANGER-RODS AND 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 galvanized steel hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
 1. Steel Turnbuckles: MSS Type 13.
 2. Swivel Turnbuckles: MSS Type 15.
 3. Malleable Iron Sockets: MSS Type 16.

2.04 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.

1. Concrete Inserts: MSS Type 18.
2. Channel Clamps: MSS Type 20.
3. Welded Beam Attachments: MSS Type 22.
4. C-Clamps: MSS Type 23.

2.05 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles and 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 Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.

2.06 ROOF CURBS AND PENETRATIONS

- A. Prefabricated roof curbs for penetrations shall be provided by this Division. The curbs shall be installed by the general contractor.

2.07 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. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

2.08 VIBRATION ISOLATION

- A. General: Equipment shall be isolated from the structure by means of resilient vibration and noise isolating supports. Supports shall be such that vibration is isolated and expansion and contraction is accommodated without creating excessive stresses in piping or equipment connections.
- B. All isolators shall be designed or treated for resistance to corrosion. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated. Structural steel bases shall be thoroughly cleaned of welding slag and primed with zinc chromate or metal etching primer. A finish coat of industrial enamel shall be applied over the primer. All isolators exposed to the weather shall have steel parts PVC coated, hot-dipped galvanized or zinc-electroplated plus coating of neoprene or bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel. Nuts, bolts and washers may be zinc-electroplated.
- C. Isolators shall be installed in such a manner that loaded deflections are compensated for initially.

PART 3 - EXECUTION

3.01 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure with maximum loading as shown below. 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. Provide all fascia boards, cleats, brackets, backing in partitions, toggle bolts, expansion shields, screws, clamps and rods, etc., for hanging of all piping and equipment included under this Division.
- C. Hangers and braces shall adequately support the piping system horizontally and vertically and shall allow for expansion and contraction without binding in sleeves or misalignment. Provide for expansion of piping with swing joints and ample sleeves.
- D. Vertical Piping: Supports for vertical piping 1-1/2 inches and smaller from wall with malleable split ring hanger. Nipples cut to fit each case. Two hangers per floor, minimum. Use clamps on every floor for pipes 2 inches and larger. In crawl spaces, support stacks on base fitting placed securely on concrete piers or masonry blocks and with pipe clamps.
- E. Horizontal piping shall be supported with hangers as follows:

<u>STEEL PIPE SIZE</u>	<u>ROD DIAMETER</u>	<u>MAXIMUM SPACING</u>
Up to 1 inch	3/8 inch	7 feet
1-1/4" inches	3/8 inch	8 feet
1-1/2 inches	3/8 inch	9 feet
2 inches	3/8 inch	10 feet

- F. Load carrying capacities of threaded steel rod based on allowable stress of 12,000 psi.

ROD SIZE-INCHES:	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4
ALLOW LOAD-LBS:	610	1130	1810	2710	3770	4960	6230	8000
- G. Generally, pipes shall be individually supported. Trapeze hangers may be used where approved. Piping shall be individually bolted to trapeze with U bolts.
- H. Piping along wall: From approved wall brackets fastened to wall with Phillips anchors or inserts.
- I. Installation: Provide pipe bars, angles, etc. as required. Anchor piping to localize expansion and prevent undue strain on piping and branches. Provide spring type hangers for vibration isolation where shown on plans and as specified in vibration isolation section. Locate hanger not more than 4 feet from elbow or tee on screwed piping. Space hangers on 3 foot center on horizontal piping 1-1/2 inch and smaller exposed at corridor ceilings and less than 8 feet from floor in finished rooms.
- J. Support from Concrete Construction: All main piping runs shall be supported from hangers secured to cast-in-place concrete inserts. Branch piping hanger supports may be field drilled

using self drilling type expansion shields equal to Phillips concrete fasteners or approved equal. Expansion shields shall not cut or unduly displace reinforcement.

- K. Support from Precast Concrete: Use toggle bolts mounted in core sections of precast concrete. Absolutely no ramset or any other power driven fasteners will be allowed in precast planks.
- L. Support from Existing Concrete: Piping may be attached to the structure using power driven fasteners. All fasteners into concrete shall penetrate the slab for a distance equal to 6 to 8 times the diameter of the shank. Power driven fasteners will not be used in concrete encased steel beams.
- M. Support from Structural Steel: Make use of existing steel members for pipe support. Provide additional structural steel members where required to accommodate hangers.
- N. Anchors: Anchor piping as shown or required to isolate expansion and prevent pipe strain due to expansion. Anchors shall be separate from other supports.
- O. Expansion Joints and Pipe Guides: Install in accordance with manufacturers recommendation. Locate additional guide within recommended distance of the first guide integral to the expansion joint. 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.
- P. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

3.02 PROVISIONS FOR MOVEMENT

- A. 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.
- B. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

3.03 PIPE EXPANSION

- A. Provide pipe expansion products to make allowance for expansion and contraction of pipe. Provide bellows type or flexible expansion loop as required.
- B. Insulated Piping: Comply with the following installation requirements.
- C. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
- D. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields.

3.04 EQUIPMENT SUPPORTS

- A. Modify structural steel Stands to support equipment mounted on the roof. Construct of

structural steel members to match existing. Provide factory fabricated tank saddles for tanks mounted on steel stands. Provide shop drawings for structural steel stands for Engineer's approval.

END OF SECTION

SECTION 23 05 30
ELECTRICAL PROVISIONS FOR MECHANICAL WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions, Division-1 Specification sections and other Division 23 specification sections, apply to work of this section.
- B. This section is a Division-23 Basic Mechanical section, and is a part of each Division-23 section making reference to electrical provisions of Mechanical work specified within.

1.02 DESCRIPTION OF WORK

- A. Extent of electrical provisions to be provided as mechanical work is indicated in other Division-23 sections, on drawings, and as further specified in this section.
- B. All work on this project will be done through a single prime contract. All power and control wiring and other electrical work shown is the responsibility of the prime contractor. These include but are not necessarily limited to the following:
 - 1. Motors for mechanical equipment
 - 2. Starters for motors of mechanical equipment whether or not starter is specifically indicated to be furnished with the mechanical equipment. Unless otherwise noted, the mechanical contractor shall provide all motor starters, and combination starters/disconnects required for mechanical equipment. Motors being equipped with adjustable speed drives (ASD's) will not require starters. The contractor will provide the ASD's.
 - 3. All electrical equipment and devices (panels, disconnects, circuit breakers, etc.)
 - 4. All interlock and control wiring required for sequence operation of mechanical devices provided for mechanical systems
 - 5. All power wiring for mechanical equipment and all power and low voltage wiring for the DDC controls
 - 6. Any power wiring required for mechanical equipment not specifically shown on electrical drawings or specified in Division 26
- C. Refer to other Division-23 sections for specific individual mechanical equipment electrical requirements.
- D. Refer to Division-26 sections for materials and methods of other electrical components of mechanical equipment.

1.03 QUALITY ASSURANCE

- A. Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Division 26 sections. Comply with applicable requirements of Division-26 sections for electrical work of this section which is not otherwise specified.
- B. Standards: For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology herein. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements. Electrical work

shall be done in accordance with Codes listed and also requirements of Division 26.

1.04 SUBMITTALS

- A. Listing, Motors of Mechanical Work: Concurrently with submittal of mechanical products listing (Basic Mechanical requirements), submit separate listing showing rating, power characteristics, application (connected equipment), and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.
- B. Include in listing of motors, notation of whether motor starter is furnished or installed integrally with motor or equipment containing motor.

PART 2 - PRODUCTS

2.01 MOTORS

- A. Manufacturer: Except where item of mechanical equipment (which otherwise complies with requirements) must be integrally equipped with motor produced by another manufacturer, provide motors for mechanical equipment manufactured by one of the following:
 - 1. Baldor Electric Co.
 - 2. General Electric Co.
 - 3. Reliance Electric Co.
 - 4. Westinghouse Electric Corp.
 - 5. U.S. Electric Motor Co.
- B. Motor Characteristics: Except where more stringent requirements are indicated, and except where required mechanical equipment cannot be obtained with fully complying motor, comply with the following requirements for motors of mechanical work:
- C. Temperature Rating: Rated for 40 deg.C environment with maximum 50 deg. C temperature rise for continuous duty at full load. Insulation shall be Class F.
- D. Starting Capability: Provide each motor capable of making starts as frequently as necessary by automatic control system, and not less than 5 starts per hour for manually controlled motors.
- E. Phases and Current Characteristics: Unless otherwise noted, provide squirrel-cage induction polyphase motors for 2 hp and larger, and provide capacitor-start single-phase motors for 1/3 hp and smaller, except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division-16 sections, and with individual equipment requirements specified in other Division-15 requirements. For 2-speed motors provide 2 separate windings on polyphase motors. Unless otherwise noted, all polyphase motors shall be suitable for 240 volt, 3 phase, 60 Hz service.
- F. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- G. Motor Construction: Provide general purpose, continuous duty motors, Design "B" except "C" where required for high starting torque. For motors controlled by variable speed drives, provide inverter duty motors that comply with NEMA MG1-Part 3 Definite Purpose Inverter-Fed Motors.

- H. Frames: NEMA No. 56 or Type T (unless otherwise noted)
- I. Bearings: Ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is normally inaccessible for regular maintenance.
- J. Where belt drives and other drives produce lateral or axial thrust, in motor, provide bearings designed to resist thrust loading. Refer to individual sections of Division 15 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
- K. Enclosure Type: Except as otherwise indicated, provide TEFC motors. Refer to individual sections of Division 23 for other enclosure requirements.
- L. Overload Protection: Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
- M. Noise Rating: Provide "Quiet" rating on motors.
- N. Efficiency: All permanently wired motors of 1 HP or more shall have a nominal full load motor efficiency not less than that required by ASHRAE 90.1. Where specified, provide premium efficiency motors.
- O. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.02 EQUIPMENT FABRICATION

- A. General: Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and OSHA compliant removable guards for motor drives, arranged for lubrication and similar running-maintenance without removal of guards.

2.03 MOTOR STARTERS

- A. Manufacturers: Subject to compliance with requirements, provide motor starters of one of the following (for each type and rating of motor starter):
 1. Allen-Bradley Co.
 2. Cutler Hammer Products, Eaton Corp.
 3. General Electric Co.
 4. Square D Co.
 5. Westinghouse Corp.
- B. General: Except as otherwise indicated, provide motor starters and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation.
- C. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
- D. Motor Starter Characteristics:
 1. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet

locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have NEC proper class and division.

2. Manual switches shall have pilot lights and extra positions for multi-speed motors.
- E. Overload protection: melting alloy type thermal overload relays.
- F. Magnetic Starters:
1. Maintained contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated
 2. Trip-free thermal overload relays, each phase
 3. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of mechanical equipment Multi-Speed starters shall be provided with integral time delay transition between "FAST" and "SLOW" speeds
 4. Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts
 5. Externally operated manual reset
 6. Under-voltage release or protection
- G. Motor Connections:
1. Liquid-tight flexible conduit, except where plug-in electrical cords are specifically indicated.
- H. Combination Non-Reversing Starters: Provide full voltage alternating current combination non-reversing starters, consisting of starter and disconnect switch mounted in common enclosure, of types, sizes, ratings, and NEMA sizes as required. Equip starters with electrical interlocks for interfacing with other starters. Equip starters with block type manual reset overload relays and with fusible disconnect switches.
- I. Provide operating handle for disconnect mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being padlocked in OFF position. Construct and mount starters and disconnect switches in single NEMA Type 1 enclosure: coat with manufacturer's standard color finish.
- J. AC Fractional HP Manual Starters: Provide single-phase fractional HP manual motor starters, of sizes and ratings required. Equip with manually operated quick-make, quick-break toggle mechanisms; and with one-piece melting alloy type thermal units. Starter to become inoperative when thermal unit is removed. Provide starters with double break silver alloy padlocked OFF. Enclose starter unit in NEMA Type 1 general purpose enclosure suitable for contacts, visible from both sides of starter; green pilot lights, and switch capable of being flush mounting; coat with manufacturer's standard color finish.

2.04 WIRING

- A. Low voltage wiring shall be no. 18 rubber covered, color coded wire or cable. Line voltage wiring shall be not smaller than #12 600 volt wire. All wire shall be run in rigid conduit with outlet boxes and fittings in a manner comparable to that specified in the electrical specifications. All ground wire shall be THHN for line voltage. All wire will be pulled to every pump, disconnect, starter motor etc. Conduit shall not be used as ground.

2.05 DISCONNECTS

- A. Non-Fused.
 - 1. Wall mounted, standard duty, single throw in NEMA-1 enclosure or NEMA 3R enclosure, weatherproof for exterior locations. Single-pole or three-pole as required with solid neutral. External handle lockable in the open position. Disconnect switches shall be provided wherever the code requires local disconnecting means.
 - 2. Make: Square D, General Electric or Westinghouse.
- B. Fused Disconnect Switches
 - 1. Single throw, quick-make, quick-break: Number of poles as required by load. NEMA-1 general purpose enclosure indoors in dry locations, NEMA 3R weatherproof enclosure outside. Standard fuse clips, lockable in open position. Rating 250 or 600 VAC as required.
 - 2. Make: General Electric, Square D, Westinghouse.

2.06 MOLDED CASE CIRCUIT BREAKERS (MCCB):

- A. Manufacturers: Subject to compliance with requirements, provide MCCB's of one of the following:
 - 1. Cutler-Hammer/Westinghouse
 - 2. General Electric
 - 3. Siemens
 - 4. Square D
- B. General: MCCB's shall be industrial grade (bolt-on) with ratings and special features as scheduled on drawings. Trips shall be thermal magnetic with inverse time delay and instantaneous time-current characteristics. 225 ampere frame and larger MCCB's shall have interchangeable trips and adjustable magnetic feature. MCCB's used outdoors shall have ambient compensating trips. MCCB's used for switching lights shall be rated for switching duty and shall be so labeled. MCCB's used for overcurrent protection for HVAC equipment shall be rated "HACR" type and shall be so labeled. MCCB's to be installed in existing panelboards shall be of the same manufacturer as the panelboard. Ganged use of single-pole breakers for multi-pole applications is not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Install motor starters, 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.
- C. Coordinate with other work including motor and electrical wiring/cabling work, as necessary to interface installation of motor starters with other work.

- D. 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 Std 486A.

3.02 ADJUSTING AND CLEANING

- A. Inspect electrical starter's operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.03 FIELD QUALITY CONTROL

- A. Subsequent to connecting wires/cables, energize motor starter circuitry and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units, and then retest to demonstrate compliance. Ensure that direction of rotation of each motor fulfills requirements.

END OF SECTION

PART 1 - GENERAL

- 1.01 RELATED WORK SPECIFIED ELSEWHERE
- A. All work of this Division shall comply with the requirements of the Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions and Division 1 Specification Sections.
 - B. Section 230510 - General Provisions.
 - C. Section 230530 - Electrical Provisions of Mechanical Work
 - D. Division 26 - Electrical
- 1.02 RELATED SECTIONS
- A. Division 26 - Electrical Identification: Engraved nameplates.
- 1.03 REFERENCES
- A. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
 - B. NEMA - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - C. CSA Approved
 - D. IEEE Standard 444 (ANSI-C343)
 - E. IEC: 146A
- 1.04 SUBMITTALS
- A. Submit under provisions of Section 01340.
 - B. Shop drawings shall include; wiring diagrams, front and side views of enclosures, overall dimensions, conduit entrance locations and requirements, nameplate legends, and enclosure details.
 - C. Product Data: Provide data sheets showing; voltage, ratings and size of switching and overcurrent protective devices, short circuit ratings, and weights.
 - D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of adjustable speed drive.
- 1.05 QUALITY ASSURANCE
- A. ASD shall have a minimum MTBF (mean time between failure) rating of 100,000 hours.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 230510.
- B. Include instructions for starting and operating ASD, and describe operating limits, that may result in hazardous or unsafe conditions.

1.07 QUALIFICATIONS

- A. Manufacturer must have a minimum of 10 (ten) years documented experience, specializing in adjustable speed drives.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site, under provisions of Section 230510.
- B. Accept ASD on site in original packing. Inspect for damage.
- C. Store in a clean, dry space. Maintain factory wrapping, or provide an additional heavy canvas or heavy plastic cover, to protect units from dirt, water, construction debris, and traffic.
- D. Handle carefully, in accordance with manufacturer's written instructions, to avoid damage to components, enclosure, and finish.

1.09 WARRANTY

- A. Provide ASD warranty for three years from date of final acceptance. Warranty shall include parts and labor.

1.10 WORK INCLUDED

- A. Provide adjustable speed drives for the following equipment. See mechanical schedules for motor sizes and voltages.
 - 1. AHU-3
 - 2. AHU-10

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. ASD shall be manufactured by owner preferred manufacturer ABB. All ASDs on the project shall be by the same manufacturer.

2.02 DESCRIPTION

- A. Provide enclosed adjustable speed drives suitable for operating at the current, voltage, and horsepower indicated on the plans. Conform to requirements of NEMA ICS 3.1.

2.03 RATINGS

- A. ASD must operate at full output, without fault or failure, when voltage varies plus or minus 10 percent from rating, and frequency varies plus or minus 2 percent from rating.

- B. ASD must not be damaged when an open circuit is introduced on the output of the ASD while the drive is actively controlling a motor or device.
- C. ASD shall be 60 Hz, voltage as indicated on the plans.
- D. Displacement Power Factor: 0.98 over entire range of operating speed and load.
- E. Operating Ambient Temperature: -10°C. to 40°C. (14°F. to 104°F.)
- F. Humidity: non-condensing to 90%.
- G. Altitude: to 3300 feet, higher by derating.
- H. Minimum Efficiency: 96% at half speed; 98% at full speed.
- I. Starting Torque: 100% starting torque shall be available from 0.5 Hz. to 60 Hz.
- J. Overload capability: 110% of rated F.L.A. (full load amps) for 60 seconds; 160% of rated F.L.A., for 0.5 seconds.
- K. The ASD must meet the requirements for Radio Frequency Interference (RFI) above 7 MHz as specified by FCC regulations, part 15, subpart J, Class A devices.
- L. In compliance with IEEE 519, the Total Harmonic Distortion for the ASD shall be no greater than 5%. When the THD is above 5% the supplier of the ASD shall provide line reactors.
- M. The ASD provided must be capable of outputting up to a 70hz signal

2.04 DESIGN

- A. ASD shall employ microprocessor based inverter logic.
- B. Control circuit shall be isolated from all power circuits.
- C. ASD shall include surface mount technology, with conformal coating.
- D. ASD shall employ a PWM (pulse width modulated) inverter system, consisting of:
 - 1. Input Section:
 - a. ASD input power stage shall convert three-phase AC line power into a fixed DC voltage via a solid state full wave diode rectifier.
 - 2. Intermediate Section:
 - a. DC bus as a supply to the ASD Output Section shall maintain a fixed voltage with filtering and short circuit protection.
 - b. DC Bus shall be interfaced with the ASD diagnostic logic circuit, for continuous monitoring and protection of the power components.
 - 3. Output Section
 - a. Insulated gate bipolar transistors (IGBT's) shall convert DC bus voltage to variable frequency and voltage.
 - b. PWM sine coded output to the motor.
- E. The ASD shall have D.C. link reactors on both the positive and negative rails of the D.C. bus to minimize power line harmonics. ASD without D.C. link reactors shall provide a minimum 3% impedance line reactor.

- F. ASD shall be rated for 100,000 amp interrupting capacity (AIC).
- G. The ASD must be amp rated at carrier frequencies at or above 10 kHz. Exception to this requirement is allowed only for ASDs providing 104 amps or more.
- H. The ASD must be selected for operation at carrier frequencies at or above 10 kHz to satisfy the conditions for current, voltage, and horsepower as indicated on the equipment schedule.
- I. ASD shall have an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and ASD efficiency while reducing noise.
- J. ASD shall include two independent remote reference inputs. One shall be 4-20 ma. The other shall be 0-10 VDC. Either input shall respond to a programmable bias and gain.
- K. ASD shall include a minimum of three multi-function input terminals, capable of being programmed, to determine their function when their state is changed. These terminals shall provide up to 20 functions, including, but not limited to:
 - 1. Remote/Local operation selection.
 - 2. Detection of external over-heat condition.
- L. ASD shall include a 0-10V DC analog output, proportional to frequency or current, for either monitoring, or "speed tracking" the ASD.
- M. ASD shall provide terminals for remote contacts, to allow starting in the automatic mode.
- N. ASD shall include at least one external fault input, which shall be programmable, for either a normally open, or a normally closed contact, for connection to firestats, freezestats, etc.
- O. ASD shall include a minimum of three multi-function output terminals, one of which shall be a fully rated form "C" contact, capable of being programmed, to determine what conditions must be met, in order for them to change their state. These terminals shall provide up to 15 functions, including, but not limited to:
 - 1. Zero speed detection.
 - 2. Low and high frequency detection.
 - 3. Missing frequency reference detection.
 - 4. Overtorque detection
- P. ASD shall include a power loss ride thru of 2000 milliseconds (2 seconds).
- Q. ASD shall be capable of restarting automatically after a power failure. ASD shall include a front mounted, sealed keypad operator, with a digital display, to provide complete programming, operating, monitoring, and diagnostic capability. Keys provided shall include commands for RUN, STOP, and RESET. Operating mode (auto or manual) and speed setting functions shall also be provided. Keypad may be of the removable type.
- R. ASD display shall provide readouts of; output frequency in hertz, output voltage in volts, output current in amps, output power in kilowatts, D.C. bus voltage in volts, interface terminal status, and fault codes.
- S. ASD shall be capable of PID (Proportional, Integral, Derivative) logic, to provide closed-

loop setpoint control capability, from a remote reference.

- T. ASD shall include loss of input signal protection, with a speed default to 80% of the most recent speed.
- U. ASD shall include electronic thermal overload protection for both the drive and motor, profilable for variable or constant torque.
- V. ASD shall include the following programming functions:
 - 1. Critical frequency rejection capability: 3 selectable, adjustable bands
 - 2. Auto restart capability: 0 to 10 attempts
 - 3. Stall prevention capability
 - 4. "S" curve soft start capability
 - 5. "Speed search" capability, in order to start a rotating load
 - 6. 15 preset volts per hertz patterns
 - 7. One adjustable volts per hertz pattern
 - 8. Current limit adjustment capability, from 30 % to 200 % of rated full load current of the ASD
 - 9. Anti "wind milling" function capability
- W. ASD shall include factory settings for all parameters, and the capability to be reset back to those settings.
- X. ASD shall include the capability to adjust the following functions, while the ASD is running:
 - 1. Acceleration adjustment from 0 to 600 seconds
 - 2. Deceleration adjustment from 0 to 600 seconds
 - 3. A minimum of three different preset speeds
 - 4. Analog output gain, to calibrate the signal for the application used
- Y. Manual Bypass shall be provided. ASD and bypass components shall be mounted in a side-by-side arrangement, inside a common NEMA 1 enclosure, fully pre-wired, and ready for installation as a single UL listed device. Bypass shall include the following:
 - 1. Input, output, and bypass contactors, to disconnect power to the ASD when the motor is running in the bypass mode
 - 2. 115 V.A.C. control transformer, with fused primary
 - 3. Thermal overload relay, to protect the motor while operating in the bypass mode
 - 4. Fused disconnect switch
 - 5. Control and safety circuit terminal strip
 - 6. "Drive-Off-Bypass-Test" selector switch
 - 7. Pilot lights for "Power On", "Running On Drive", "Running On Bypass" and "Fault"

2.05 PRODUCT OPTIONS

- A. Current limiting, fast acting input fusing, for the protection of ASD semiconductor devices.
- B. Serial communications gateway, for either RS-232 or RS-485, to provide interface from an ASD to; a computer, a Program Logic Controller (PLC), or Building Automation System, for those units which need to interface with such.

- C. PID EPROM for those units which shall be controlled directly by pipe or duct static pressure sensors.

2.06 FABRICATION

- A. Enclosure: NEMA Type 1 for indoor application, NEMA 3R for outdoor application.

2.07 SOURCE QUALITY CONTROL

- A. In-circuit testing of all printed circuit boards shall be conducted, to ensure the proper mounting and correct value of all components.
- B. All printed circuit boards shall be burned in for 96 hours, at 85°C.
- C. Final printed circuit board assemblies shall be functionally tested, via computerized test equipment. All tests and acceptance criteria shall be preprogrammed. All test results shall be stored as detailed quality assurance data.
- D. All fully assembled controls shall be functionally tested, with fully loaded induction motors. The combined test data shall then be analyzed, to insure adherence to quality assurance specifications.
- E. Inspect and production test, under load, each completed ASD assembly.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that surface is suitable for ASD installation.
- B. Do not install ASD until the building environment can be maintained, within the service conditions required by the manufacturer.

3.02 INSTALLATION

- A. Install ASD where indicated, in accordance with manufacturer's written Instructions and NEMA ICS 3.
- B. Tighten accessible connections and mechanical fasteners after placing ASD.
- C. Provide neatly typed label on each ASD, identifying nameplate horsepower, full load amperes, model number, service factor and voltage/phase rating.
- D. Where a disconnect is provided between the ASD and the controlled equipment, provide a contactor to turn off ASD when the disconnect is opened.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing to be performed under provisions of Section 15010.
- B. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

3.04 MANUFACTURER'S FIELD SERVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions, Division-1 Specification sections and other Division 23 specification sections, apply to work of this section.

1.02 RATING

- A. All insulation systems, including jackets and adhesives shall be U.L. rated and FM approved. All insulation for indoor use shall have a maximum permanent flame spread rating of 25 or less and a smoke developed rating of 50 or less, as tested by ASTM E 84 (NFPA 255) method. Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150. Submit smoke and flame ratings for every material proposed for use.
- B. Make: Certain Teed, Owens Corning, Johns Manville, Knauf and PPG.

1.03 SCOPE

- A. Furnish and install insulation for the following: Note scope varies depending on alternates selected
 - 1. Hot water piping.

1.04 QUALITY ASSURANCE

- A. Insulation contractor shall be member of either the National Insulation Association (NIA) or the Southeastern Insulation Contractors Association (SEICA).

1.05 SUBMITTALS

- A. Submit evidence of membership in NIA or SEICA.
- B. 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.
- C. Submit, if requested by Designer, manufacturer's sample of each piping insulation type required, and of each duct and equipment insulation type required. Affix label to sample completely describing product.

PART 2 - PRODUCTS

- 2.01 Type 1: Thermal Pipe Insulation with Jacket. Preformed Fiberglass Pipe insulation complying with ASTM C547, Class 3, rigid, molded pipe insulation, noncombustible. Maximum K-factor of .24 at mean temperature of 75°F. All insulation shall have a jacket of white kraft paper reinforced with a glass fiber yarn and bonded to an aluminum foil, with self sealing longitudinal laps and butt strips. Jacket shall comply with ASTM C1136 (Type 1).

Insulation and jacket shall be equal to Johns Manville Micro-Lok with AP-T Plus.

2.02 Insulate all fittings, valves and strainers with molded fittings, mitered segments of pipe insulation or over- sized pipe insulation held in place with wire. Finish in accordance with manufacturer's recommendations to comply with the UL Systems listing. Preformed jackets of PVC material as manufactured by Zeston, Inc., may be used at fittings.

2.03 FIELD APPLIED JACKETS

- A. PVC Plastic: Zeston 2000 or equal. One piece molded type fitting covers and jacketing material, gloss white.
- B. Canvas Jacket: UL listed fabric, 6 oz/sq yd, plain weave cotton treated with dilute fire retardent lagging adhesive.
- C. Aluminum Jacket: 0.016 inch thick sheet, corrugated finish, with longitudinal slip joints and 2 inch laps, die shaped fitting covers with factory attached protective liner.
- D. Stainless Steel Jacket: Type 304 Stainless steel, 0.10 inch, corrugated finish.

2.04 TYPE 1 PIPE INSULATION THICKNESS

- A. Insulate hot and chilled water pipe and condensate drain pipe sizes with wall thicknesses as indicated in the following table.

	1" and smaller	1 1/4" to 2"	2 1/2" to 4"	5" and larger
Hot Water	1 1/2"	1 1/2"	1 1/2"	2"

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. All insulation shall be applied by experienced pipe coverers and journeymen in accordance with best trade practice. Work shall be as recommended by manufacturer's latest printed installation directions. Test, inspect, and clean all surfaces to be insulated before applying insulation. Take all possible precautions to protect work of other trades. Provide protective covering as required to accomplish this and be responsible for returning all equipment and material to its original new condition and appearance where damage occurs due to neglect.
- B. Apply adhesive to exposed risers to prevent slipping and turning.
- C. Butt covering neatly to walls, floors, ceiling. Apply bands at end and position so band covers gap between surface and insulation where exposed.
- D. At butt ends of insulation the jacket material shall be pulled over exposed ends and secured with bands to give a neat and finished appearance. Exposed fiberglass material will not be permitted. In location where it will be exposed to view do not apply insulating cement until there is heat on lines.

- E. Do not cover nameplates on equipment.
- F. Do not insulate vibration eliminators.
- G. Provide aluminum jacket on all exterior piping.
- H. Provide canvas jacket in mechanical rooms.

3.02 PIPE INSULATION SHALL BE APPLIED AS FOLLOWS

- A. Type 1 - Thermal Pipe Insulation with Jacket.
 - 1. Hot water piping.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. All work of this Division shall comply with the requirements of the Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions and Division 1 Specification Sections.
- B. Section 230510 - General Provisions.
- C. Division 26 - Electrical

1.02 DESCRIPTION

- A. Furnish and install an expansion to the existing DDC Control System as herein specified, a web based Energy Monitoring and Control System with thermal graphics equal to present system to provide night setback, demand limiting, optimized startup and other control functions. The system shall be complete in all respects, including thermostats, relays, contacts, etc. to provide the function described hereinafter regardless of whether thermostats, relays, etc. are specifically mentioned or not.
- B. Alternate proposals or substitutions, where provided, must conform to plans or specifications in detail, and any deviation, no matter how minor, must be included in the list of deviations submitted with the bid. Any proposed system with deviations which, in the opinion of the Owner and/or the Engineer, alter the basic intent of the specifications will not be accepted.
- C. The system being installed shall be compatible with current and future plans for control and monitoring of the HVAC systems in the building.
- D. Provide the following electrical work as work of this section, complying with requirements of Section 230530 and Division 26 sections:
 - 1. Control wiring between field-installed controls, sensors, relays, transducers, indicating devices, and unit control panels. Include power wiring from nearest electrical breaker panel with available capacity to temperature control panels or other terminal devices.
 - 2. Interlock wiring between electrically-operated equipment units and between equipment and field-installed control devices.

1.03 WORK INCLUDED

- A. The following work is specifically included without limiting the generality implied by these specifications and drawings.
 - 1. Installation of and connection to existing microprocessor based direct digital control (DDC) system to control HVAC equipment and systems for space temperature control, night setback, demand limiting, etc.
 - 2. Cutting and patching as required for the introduction of work as shown on the plans and as specified in this Division.

3. Tie system controller to owner's Ethernet switch to allow access over the internet.
4. Provide all internal and external wiring for the Direct Digital Control System.
5. Provide Control Valves, Sensor Wells and other items of equipment indicated on the Drawings or in the Specifications to the Mechanical Contractor for installation.
6. Proper check out and verification of sensor accuracy and sequence operation per specifications. Include coordination effort with owners balancing contractor.

1.04 SHOP DRAWING

- A. Submit for approval, apparatus bulletins and data sheets for all controls components, valves, damper, and room schedules showing size, configuration, capacity and location of all equipment. Include complete control diagrams with system description, wiring diagrams and installation and maintenance instruction.
- B. All control wires on the line side of relay, starter or contactor coils, pilot lamps or other utilization components shall be color coded and labeled. All control wires on the neutral side of utilization components shall be white.

1.05 ELECTRICAL WIRING

- A. Refer to Electrical Specifications for wiring required under this Section.
- B. All wiring shall be done in accordance with the latest edition of National Electric Code, Division 26 and the North Carolina State Building Code.
- C. All wiring associated with direct digital control and Micro-Processor System shall be by this Division.
- D. Wiring methods:
 1. All line voltage wiring shall be in conduit.
 2. All low voltage control wiring shall be in conduit. Must be labeled DDC controls. Route groups of wires together in one bundle.
- E. All penetrations of rated walls and floors shall be firestopped in accordance with the UL details indicated on the drawings.

1.06 GUARANTEE

- A. Control system specified herein shall be guaranteed free from original defects in material and workmanship for a period of two years of normal use and service after final inspection and acceptance of the project. Provide a paid in full service agreement in the name of the Owner, including material and labor, for two years to run concurrently with guarantee period. This service is to include both "break down maintenance" initiated by a telephone call from the Owner and a minimum of two preventative maintenance inspections and adjustments per year. Same-day service shall be guaranteed if a service call, from the Owner to Contractor, is placed before 12:00 noon.
- B. The control system manufacturer shall state that equipment compatible with that being bid will be available for at least three years after acceptance of this work. Support and spare parts shall be available for at least five years.

- C. The manufacturer shall provide, free of cost, any upgrades to the software for a period of three years from acceptance of this work.

1.07 QUALIFICATION FOR MICROPROCESSOR BASED ENERGY MANAGEMENT EQUIPMENT SUPPLIER

- A. The installation shall be Honeywell with Tridium front end, installed by MSS.

PART 2 - PRODUCTS

2.01 MICROPROCESSOR BASED CONTROL SYSTEM (MPS) FOR ENERGY MANAGEMENT

- A. General Requirements: Furnish and install a networking microprocessor based Energy Management System hereinafter referred to as MPS for the monitoring and control of the mechanical and electrical equipment designated. It is the intent of this specification to describe the performance requirements of the MPS. Therefore, these specifications describe the operational functions of the system and present minimal requirements for equipment to accomplish these functions. The MPS shall be comprised of the hardware and the software required to perform all designated tasks as described hereinafter. The installation may consist of one or more individual MPS panels. The term MPS refers to each individual panel as well as the entire installation. An MPS shall be able to communicate with other MPS by local network through a twisted pair or shielded wire. A local network may be comprised of more than thirty (30) MPS. The local network shall be able to interface through the Web via an Ethernet port. The MPS system shall be a true distributive processing system and each MPS shall be a self-contained programmable control and monitoring system. Each MPS shall be able to perform its control, energy management and alarming functions independently from other units. The MPS shall consist of one or more logic panels depending upon control strategy and number of points controlled and/or monitored. The MPS shall not be dependent upon master unit or CPU for control logic or data. A failure of one MPS will not adversely affect the operation of other MPS of the distributed network.
- B. Hardware: Each MPS controller shall be UL listed or shall comply with UL 916 standard for Energy Management. Power Supply to the panel shall be isolated with UL labeled Class II transformer. The primary side of the transformer shall be protected by overcurrent protection, and the secondary side shall have fused disconnect. Circuit breaker type disconnect at the secondary side will not be acceptable. Primary side protection shall not be required on small Application Specific Controllers (ASC's) used to control small individual pieces of equipment (fan coil units, etc.) The MPS shall be provided as a networking stand-alone energy management system enclosed in one or more sturdy metal enclosures containing a microcomputer, separate peripheral ports for CRT, printer and auto answer/auto dial modems, a network communications port, programmers keyboard, alpha-numeric display, power supplies, battery backup, and input/output control boards. Each MPS shall be able to gather information and/or update minimum four (4) times a second. All stand-alone units shall be accessible via the network through peripheral ports on the network units following proper password access code entry. All peripheral communication as well as global data transfer between network units shall be accomplished through the local network. For owner-operator independence, the microcomputer shall be completely field-programmable through integral keyboard entries or through the maintenance department's laptop computers.
- C. Status Indication: The MPS shall include a 24 hour time-of-day clock with standard calendar and full battery backup maintaining clock, building operating program and RAM memory for

a minimum of thirty hours. A built-in charging circuit shall maintain battery at a full charge. All network units in the local network shall synchronize their time of day clocks each 24 hours. Each network port on the network will allow access and programming to each of the other MPS units. A separate access code is maintained for each MPS unit. All system memory shall be programmable through these network ports and data entered into memory shall be recalled and displayed for operator review. Additions or deletions shall be made when the system is on-line. Systems requiring shutdown of any part shall not be acceptable. Check sum verification shall insure data integrity during loading operation. This dump/reloading process shall not require the use of the central console. A memory dump/reload should also be obtainable at a remote site. The MPS input/output hardware shall be compatible with electronic HVAC control systems for total building optimization, energy management and facilities management, such as abnormal condition alarm reporting. The MPS shall be capable of communication through the internet via an Ethernet link provided in the building. The MPS shall be furnished with a user programmable language and sufficient internal memory to provide at least the following software capabilities:

1. electric demand limiting
2. time programmed commands to include two state and setpoint control
3. duty cycle control
4. optimum start-up control
5. holiday scheduling
6. time of day
7. password entry
8. direct digital control with P.I.D
9. any other programs specified in the Input/Output schedule.

In addition to the above EMS and HVAC control programs, provisions shall be made for on-line programming and override, memory dump/reload, and trend log output to the central console or the modem. The data shall be stored on a digital storage media after performing the memory dump procedure. Data that is unique for the particular facility shall reside in RAM which will enable the operator to enter the individual program parameters, such as on/off times, demand setpoint limits, etc. These entries shall be protected by a minimum 30 hour battery backup on all volatile memory components in the event of building power failure. The software shall be capable of communication via the web. It will be possible to interrogate memory, change memory elements, or manually override building equipment via the web. Program upload/download shall be possible between MPS on the network.

- D. Surge and Lightning Protection Line voltage protection: The DDC system control panels shall be powered by 120 VAC circuits provided with surge protection.

2.02 GENERAL APPLICATION PROGRAMS

- A. Each stand-alone networking unit shall be programmable through the integral keyboard or peripheral terminal. Software architecture shall allow both standard setups of point types, EMS Programs, loops or related parameters as well as custom program linking with math and logic. In addition, the MPS shall allow the building operators a means of interrogating input/output sensor conditions, such as interrogating the values of analog sensor input upon request, or the status of control via the standard keyboard and display unit, or through a remote CRT Terminal Unit. The MPS shall not be dependent upon a master control unit or CPU for control logic or data. The system access shall be restricted by at least three levels of password security. As a minimum, the system shall be programmed for six users each with designated three letter Operator ID and four- character password.

- B. Each of the MPS units on the network shall be able to access global information. Such information as outside air temperature, demand shed commands, and enthalpy changeover etc. routines can be shared by all units on the Network.
- C. Network data can be trended from each MPS on the network for central printout and alarm through locally connected printers on the network or over phone lines with dial-up modems for remote alarming.
- D. Local Network status shall monitor all communication in the network. Loss of any data transfer will trigger alarms as well as default sequences to maintain system integrity. MPS will execute a pre-defined mode of operation if the system fails.
- E. Building alarm monitoring and reporting shall be generated based upon the presence of abnormal alarm conditions such as high/low temperature input or abnormal change of state such as freeze stats, fire stats, filter alarm switches, etc. Printed report upon alarm condition shall be generated and reported to designated terminal via Local Network System.

2.03 TIME PROGRAMMED COMMANDS (TPC)

- A. The MPS system shall provide automatic start-up and/or shutdown of selected remote equipment and automatic adjustment of setpoint data according to pre-set schedules stored in the computer. All remote fans, pumps, motors, lights, HVAC systems, boilers, chillers, etc. or any device which operates on a preset time basis can be assigned to this program.
- B. TPC shall operate in accordance with a yearly calendar with automatic adjustment for daylight savings time and leap year.
- C. TPC shall incorporate holiday schedules capability which will automatically bring up predefined holiday schedules of operation. Holidays can be scheduled up to one year in advance and shall be capable of any number of holidays per year. The technique for scheduling holiday operation shall be to specify the date of the beginning day of the holiday and the date of the ending day of the holiday. For each of those days specified as a holiday, time clock will follow its unique holiday schedule.
- D. TPC shall provide time dependent programmable two state control. This time program shall contain unique schedules which may be defined with appropriate start/stop times for each piece of controlled equipment. There should not be any limitation of number of schedules or number of start/stop per schedule. In addition to the time dependent two state control, TPC shall also provide time dependent setpoint control. This control provides the capability of outputting proportional setpoint values of a pre-determined, pre-defined setting in accordance with the time of day and day of week. This program shall be used to accomplish night setback, morning warm-up, and normal daily operating setpoints of all control system loops, controlled by the MPS.
- E. As with the two state control, time dependent setpoint control shall be subject to the holiday schedule. The setpoints desired shall be user definable. The operator shall be capable of reading and/or altering all stored data pertaining to time of day, day of week, on/off times, setpoint values, and holiday designation.

2.04 OPTIMUM START PROGRAM (OS)

- A. The optimum start-up time of assigned equipment shall be determined based on a software

calculation which takes into consideration outdoor air conditions, space conditions, and building R factor. Any or all zones and their associated loop control shall be capable of being optimized by the optimum start program. The software program shall be capable of precisely determining the ideal start-up time in the heating and cooling system. Each zone being optimized may have its own unique set of variables, such as temperature and occupancy time.

- B. The optimum start program shall control the start-up of the HVAC cooling and heating equipment to achieve the target occupancy space temperature at the precise time of building occupancy. By use of the central console keyboard or from a remote terminal the operator shall have the ability to program the occupancy time and target temperature for each zone to be optimized. A unique built-in "learning" technique shall allow the MPS to automatically adjust itself to the most effective time to start equipment in order to achieve the desired occupancy target temperature. Each zone being optimized shall have its own learning curve. For zones served by heat pumps, OS program shall utilize a strategy to start equipment early from heating setback to avoid the use of auxiliary electric resistance heaters.

2.05 CUSTOM CONTROL

- A. The MPS shall utilize real-time calendar year time functions. The processor shall be able to evaluate seconds, minutes, hours, days of week, days of month, and years. The MPS shall make an automatic adjustment for leap years. The battery back-up shall accurately maintain all time functions in the event of power loss. The MPS software shall allow individual programmability of each load as well as coordinated control of loads within one MPS, as well as between different MPS. The MPS software must be of a user programmable type which will permit the user/operator easy communication with the processor. The MPS software will provide an editing feature so that the user can enter control programs as well as alter, delete, or add to control programs. The MPS software will provide a control simulation feature thereby allowing the user to pre-test the system software prior to, or while external wiring connections are being made to the system. The system shall have the ability to perform the following pre-tested control algorithms:
 - 1. Two-position control
 - 2. Proportional control
 - 3. Proportional plus integral control
 - 4. Proportional, integral, plus derivative control
 - 5. Automatic loop tuning
- B. The MPS software must make available elapsed seconds and minute timers for use in control software. Such timers will provide for the elimination of equipment short cycling.
- C. The MPS software must be structured in such a manner as to allow the user to develop his own user programs to fit the energy management and control strategy needs of the specific installation at hand. The MPS software must use a straightforward English format. The MPS software must have the capability of performing program control strategies based upon any or all analog and digital inputs and/or outputs within the specific MPS, or via the intercommunications lines, any or all analog and digital inputs and/or outputs from different MPS units. The MPS must have a programmable Daylight Savings Time feature which is user definable.
- D. The MPS shall allow the user to input full English identifications of all digital inputs, analog inputs, digital outputs, analog outputs, and counters. When the printout of data is requested, the full English identification will be printed with the data. The user shall be able to directly

identify equipment status, system operation, digital and analog input data, without the need to reference tables or wiring diagrams.

- E. The MPS shall be able to perform special priority actions and strategies upon return of power after a power loss at the facility.
- F. The MPS software shall be capable of performing special control strategies and alarming based upon occurrence of one or more emergency conditions such as equipment failure and temperature, pressure, flow or humidity readings which are determined by the processor to be out of a pre-determined range. The user must have the ability to adjust the emergency conditions at any time.
- G. The MPS software shall be capable of scheduling hours of occupancy for a full year in advance. The software must have the capability of scheduling 20 or more holiday schedules and vacation periods. Such events must be user-adjustable. The user will have the capability of adjusting such events at any time.
- H. The MPS software shall employ internal machine diagnostics and parity checks to detect hardware or software faults. Upon itemization of such failure, the MPS shall shut down in a fail-safe manner as described hereinafter.
- I. Alarming Requirements:
 - 1. All alarms shall be immediately displayed on the central console.
 - 2. The MPS shall have the capability to initiate an alert to service personnel.
 - 3. The sending of the alarm report may be activated by user-defined "out of limits" conditions as determined by the input and output data to the MPS.
 - 4. The alarm report shall be user-definable and will include the facility identification, the specific MPS identification, time of alarm activation and the alarm condition. Each MPS shall maintain up to 16 different alarm reports.
 - 5. The MPS shall also store the time of alarm activation and the time at which the alarm is cleared in its data file.
 - 6. Each MPS of the distributed processing network shall have the capability to activate the sending of an alarm report to a remote site.
- L. Control Points:
 - 1. Output: As required to perform control function outlined in the system description hereinafter. The processor shall be capable of expanding the output control points as required for future growth.

2.06 DIRECT DIGITAL CONTROL (DDC)

- A. Direct control capability using a custom control program, manual command, or time program initiated commands shall be provided as a standard feature of this system. The Digital Output board shall be used for two state commands to loads, such as stop/start, day/night, open/close, etc. The digital output board shall provide a normally closed or open dry contact output with a minimum contact rating of 1 amp at 24 volts. The Digital Input board shall accept an input voltage of 0 to 2V for OFF and 10 to 24V for an ON, which can represent status or alarm signals from monitored devices, or can count pulses from an energy demand generator. The analog input board shall accept 1 to 11 volts or 4 to 20 ma dc. Analog inputs will be scaled to readout in engineering units, as appropriate. The analog output board shall be used for varying outputs (4-20 mA, 0-20 VDC, etc.) used for controlling modulating

valves, dampers, etc.

- B. Enclosure: The MPS shall be in a NEMA 1, 16-gauge steel cabinet. The cabinet door shall include a key lock latch and shall be made of steel with welded seams and corners. The cabinet will contain sufficient terminal strips for input/ output wiring and for an enclosed block for connection of 120 volts 60 Hz power. The I/O terminal shall be designed for easy installation of field cables. Terminal strips shall be clearly marked for ease of installation. The field breakdown of the panel must be possible without the need to disconnect the field wiring.
- C. Make: Control system shall be by reusing the existing Tridium Control system. Provide new control modules same manufacturer as existing control system to achieve control sequence.
- D. Inclusion above does not constitute automatic pre-qualification. Suppliers still have to prove that they meet the specifications.

2.07 SENSORS AND TRANSMITTERS

- A. Outdoor Sensor shall be mounted in the outdoors on the north side of the building where natural air flow occurs, away from any artificial affect from mechanical sources. The temperature range shall be -40 to 220 deg. F. A sun shield and weatherproof assembly for mounting to 1/2 inch rigid conduit must be provided.
- B. Differential Liquid Pressure Switches shall be piped in parallel across all water circuits for positive indication of flow. Snap action SPDT switches shall operate from a neoprene slack diaphragm, corrosion-resistant stainless steel diaphragm or copper diaphragm capable of being adjusted through the total pressure range.
- C. Water Temperature Sensors shall have a temperature range of 40 to 250 deg. F. Provide brass or stainless steel thermowells and install sensor probe with heat conductive grease. Probe and sensor shall be removable without breaking fluid seal. Install sensors in top of pipe for horizontal runs to prevent condensation from flowing to sensor head.
- D. Differential Pressure and Pressure Sensors: Sensors shall have a 4-20 mA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging the device. Accuracy shall be within 2% of full scale.

2.08 CONTROL AND COMPUTER INTERFACE RELAYS

- A. Relays shall be plug-in type with blade type terminals (not pin type). Relays shall be furnished with separate relay base for ease of serving. Relays shall be furnished with SPDT, DPDT, 3PDT or 4PDT configuration as may be required. Relays shall have a minimal contact rating of 10 amps at 240 volts. Relay mechanical life expectancy shall be rated for 50,000,000 or more operations.
- B. Coil resistance shall be low VA type.

2.09 ELECTRIC OPERATORS

- A. Size electric actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or two-position action as specified. Actuators shall be Belimo. Where two or more actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable startpoint and operating range.

PART 3 - EXECUTION

3.01 STARTUP

- A. Calibrate and adjust all control equipment and place systems into operation. This shall include a systematic operational check of all control devices with particular attention to the following:
 - 1. Tag all equipment involved with this contract with permanent Bakelite lamichord tags. Stick-on type labels will not be acceptable.
 - 2. Check out sequence of all equipment in all operating modes.
 - 3. Set clock for proper operation.
 - 4. Program the system with initial schedules and setpoints after discussions with the Owner.

3.02 SYSTEM TESTING

- A. The contractor shall perform the following tests with the Commissioning Agent and the Owner's representative. The contractor shall provide one week's notice before testing shall occur. The contractor shall provide a report on all discrepancies/errors that were uncovered and corrected during the system testing.
- B. Temperature Sensors: Measure temperature with calibrated thermometer or temperature sensor. Touch or otherwise disturb the sensor to verify the sensor being measured is connected to the correct point. Verify operation of the manual override and manual adjustment where applicable.
- C. Pressure Sensors and Transducers: Verify offset and gain calibration of every device.
- D. Verify output operation of all relays and verify they are connected to the correct point
- E. Valves and damper strokes: Verify valve and damper stroke as compared to as-builts. Verify software stroke data corresponds with actual valve and damper strokes.
- F. Provide graphical trends of all setpoint control, both PID, two position, and floating. Verify PID loops have been "loop tuned."
- G. Verify each process in the Sequence of Operation.

3.03 GENERAL REQUIREMENTS

- A. Install temperature sensors and manual overrides at locations shown on the drawings.
- B. Manual overrides shall switch systems from unoccupied mode to occupied mode for a programmable length of time. Activation of the manual override for a particular system shall automatically bring on and control all other equipment needed by the system. This will include all needed hot water generators chillers, pumps, etc.
- C. Provide alarms and trend logs as detailed in the Input/Output Schedules shown on the plans. The points shown in the Input/Output Schedule are the minimum points to be provided. The Contractor shall provide additional Input/Output points, as required, to provide the performance described in this section and sequences of operation shown on plans.

- D. In the event of the MPS failure, all systems controlled by the particular MPS panel shall fail in the occupied mode of operation.
- E. Equipment serving a specific building zone shall be run according to the zone's own occupancy schedule. The Owner shall provide initial occupancy schedules for each zone to the Contractor. The Contractor shall include each specific zone schedule in the initial programming of the MPS. The Owner shall have the capability of modifying these schedules whenever desired.
- F. Laminate one copy of the panel layout and install in pouch in each control panel. Provide 2 additional copies to the owner.
- G. Provide graphical programming of the system, including automatically updating graphic screens that demonstrate building conditions and the operation of each piece of equipment and system.
- H. Upon startup of the system, the Owner's maintenance personnel shall be provided with 2 hours of a planned and progressively advanced on-site training by a factory trained manufacturer's representative on the operation and maintenance of the DDC Control System. System startup time shall not apply toward this training time.

3.04 SEQUENCE OF OPERATION

- A. The Contractor shall examine the Sequence of Operation in the contract documents and advise the Engineer of any anticipated problems in programming the sequence and submit specific recommendations for modifying the sequence. The Contractor shall participate in discussions with the Owner and Engineer to develop the final Sequence of Operation. It shall be the contractor's responsibility to program the sequence and make any necessary changes for proper and optimal system performance. The Contractor shall use controllers that are capable of providing the full final sequence of operation for each particular application. Any installed controllers that are proven not to have that full capability shall be replaced by the Contractor with the appropriate controllers.
- B. See the Drawings for the Sequence of Operation and Points List.
- C. A meeting shall be scheduled prior to installation and programming of the DDC system between the mechanical contractor, controls subcontractor, engineer, and owner to refine control strategies and determine zoning and scheduling.

END OF SECTION

SECTION 23 20 10

WATER PIPING SYSTEMS AND HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions and Division-1 Specification sections, apply to work of this section.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. ASME Compliance: Fabricate and install water piping in accordance with ASME B31.9 "Building Services Piping".

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide pipes and pipe fittings complying with Section 232160 in accordance with the following listings.
- B. 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.

2.02 BASIC PIPES AND PIPE FITTINGS

- A. Heating Hot Water Piping
 - 1. Pipe Size 2" and smaller: Black steel pipe; schedule 40; wrought-steel butt welding fittings with welded joints or malleable-iron threaded fittings and joints.
 - 2. Pipe Size 2-1/2" and Larger: Black steel pipe; Schedule 40; wrought-steel butt welding fittings with welded joints.

2.03 VALVES

- A. Provide valves complying with Section 230523 as follows:
 - 1. Sectional Valves:
 - a. 2-1/2" and Smaller: Full Port Ball valves.
 - b. 3" and Larger: Butterfly valves.
 - 2. Shutoff Valves:
 - a. 2-1/2" and Smaller: Full Port Ball valves.
 - b. 3" and Larger: Butterfly valves.
 - 3. Drain Valves - 2" and Smaller: Standard port, hose end Ball valves.
 - 4. Check Valves - All Sizes: Swing or wafer check valves.

2.04 SPECIAL DUTY VALVES

- A. Safety Relief Valves: 75 psig working pressure and 250 deg F maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure and Btu capacity.

2.05 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 225 deg F operating temperature; manually operated with ball valve; above ceilings it shall have 1/8 inch discharge connection, with outlet pointed down at convenient location for draining. In mechanical rooms it shall be 1/2" copper pipe, piped down wall with ball valve 3' off floor, and pipe to drain.
- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240 deg F operating temperature; and having 1/4 inch discharge connection, with outlet pointed down at convenient location for draining.
- C. Y-Pattern Strainers: 125 psig working pressure cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2 inch and larger, threaded connections for 2 inch and smaller, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
- D. Basket Strainers: 125 psig working pressure; high tensile cast-iron body (ASTM A 126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.

PART 3 – EXECUTION

3.01 INSTALLATION OF PIPING

- A. Install eccentric reducers where pipe is reduced in size in direction of flow, with tops of both pipes and reducer flush.
- B. Install supply piping with 1/32" per foot (1/4%) downward slope in direction of flow.
- C. Install return piping with 1/32" per foot (1/4%) downward slope in direction of flow.
- D. Connect branch-feed piping to mains at horizontal center line of mains. Connect run-out piping to branches at horizontal center line of branches.
- E. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- F. Provide manual air vents at system high points.

3.02 INSTALLATION OF VALVES

- A. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more hydronic terminals or equipment connections, and elsewhere as indicated.

- B. Shutoff Valves: Install on inlet and outlet of each mechanical equipment item, and on inlet of each hydronic terminal, and elsewhere as indicated.
- C. Drain Valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic piping system.
- D. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
- E. Relief Valves: Install relief valves on low side of reducing valves and expansion tanks. Pipe relief valve outlet to the nearest floor drain.

3.03 EQUIPMENT CONNECTIONS

- A. Connect piping 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. Install full port ball valves for all connections of ferrous pipe to non-ferrous pipe.

3.04 INITIAL CLEANOUT

- A. After system checkout, flush entire new portion of system prior to operation. This cleanout operation shall include cleaning of all strainers and dirt legs.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of pipes and pipe fittings required is indicated on drawings and/or specified in other Division-23 sections.

1.03 QUALITY ASSURANCE

- A. Welding: Qualify welding procedures, welders and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and project site welding of piping work. Owner reserves the right to perform nondestructive testing of welded pipe joints by radiographic inspection whether or not explicitly required by code.
- B. All welding of piping up to the second stop shall be done by the holder of an ASME "PP" Stamp.
- C. Owner reserves the right to utilize any testing procedure listed in Chapter VI ANSI/ASME B31.1 to verify structural integrity of any weld(s) not meeting Engineer's approval. If integrity of weld(s) is found to be in compliance with ANSI B31.1, Owner will pay for the additional testing cost. If weld(s) is found to be deficient, contractor shall be responsible for all costs associated with the testing and repair of the weld(s).

PART 2 - PRODUCTS

2.01 GENERAL

- A. Where called for in the scope or where shown in drawings, use applicable products from those specified below. All pipes shall be American-made.
- B. Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
- C. Pipe/Tube Fittings: Provide factory fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

2.02 STEEL PIPES AND PIPE FITTINGS

- A. Applications (Hot Water)

1. Carbon Steel Pipe: Schedule 40 (minimum) ASTM A 53 for piping 4" and larger, A 106 or A 120 for piping 3" and smaller; except comply with ASTM A 53 or A 106 where close coiling or bending is required.
2. Malleable-Iron Threaded Fittings: ANSI B16.3; plain or galvanized as indicated.
3. Malleable-Iron Threaded Unions: ANSI B16.39; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.
4. Threaded Pipe Plugs: ANSI B16.14.
5. Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
 - a. Material Group: Group 1.1
 - b. End Connections: Buttwelding
 - c. Facings: Raised-face
6. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe
7. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2", and where pipe size is less than 1-1/2", and do not thread nipples full length (e.g., no close-nipples)

2.03 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Provide welding materials to comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
- B. Provide Blue, Black or equal pipe joint compound.

2.05 DISSIMILAR PIPE UNIONS

- A. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.
- B. Piping Connectors for Dissimilar Pressure Pipe (Dielectric Union to be full-port, teflon seat ball brass valves): Provide brass ball valves to effectively isolate ferrous from non-ferrous piping (electric conductance), prevent galvanic action, and stop corrosion. Do not use rubber gasket type Dielectric Unions

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leak-proof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. All 90-degree elbows shall have long radius. Two 45-degree elbows in lieu of one 90-degree elbow are not permitted where short elbows are used. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance. Comply with ANSI B31 Code for Pressure Piping.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs unless such routing is clearly indicated on the drawings.

Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent -enclosure elements of building. Provide manual air vents at all high points in the piping. Provide a system drain and drains at all low points in the piping to allow complete system drainage. All vent and drain piping within the mechanical room shall run down the wall to the floor drain with shut-off ball valves located four feet above the ground. All other vents shall be piped to a nearby location facing downwards.

3.02 PIPING SYSTEM JOINTS

- A. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- B. Weld pipe joints in accordance with ASME B31.1 or ASME B31.9, as applicable.
 - 1. Welding: Pipe welding in sizes 2 inches and smaller may be either by the Manual Metallic Arc Process or the Oxyacetylene Welding Process and in sizes larger than 2 inches shall be by the Manual Metallic Arc Process with coated electrodes.
 - 2. All welding of steam piping shall be done in conformance with Chapter V of the latest edition of the ANSI/ASME Code for Power Piping B31.1.
- C. Operators who are to do the welding must be properly qualified to do satisfactory work. Proof of an operator's qualifications shall be either the Contractor's record of suitable tests passed within the preceding 90 days while in the employ of the Contractor, or maintaining his qualifications by welding at least every 90 days since last test. Any workman considered by the Engineer as not having the skill necessary for the work shall be required to pass an appropriate qualification test or shall be at once barred from further welding on the job.
- D. Joints shall be properly beveled, thoroughly cleaned of rust or other foreign matter, and degreased before welding. Metallic arc-welding electrodes shall conform to ASTM A233. Oxyacetylene welding rods shall be commercial steel gas welding rods and shall conform to ASTM A251, GA60.
- E. All piping connections shall be with pre-manufactured fittings (T, elbow, etc.) or with "weldolets," "threadolets" or "sockolets." This includes instrumentation such as thermometer wells, etc.
- F. "Weldolets" with outlet size 2-1/2" and larger and "Threadolets" or "Sockolets" with outlet size 2" and smaller may be used for branch takeoff up to one half (1/2) diameter of main. Use "Threadolets" where threaded fittings are specified and use "Sockolets" where socket weld fittings are specified. Materials of "Weldolets" and "Threadolets" shall match material of piping.
- G. Mitered ells, welded branch connections, notched tees and "orange peel" reducers are not allowed. Unless specifically indicated, reducing flanges and reducing bushings are not allowed.
- H. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform

compression of gaskets.

3.03 CLEANING, FLUSHING, INSPECTING

- A. Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Flush system with water until it runs clean. If Owner desires, introduce chemicals provided by Owner unless specific section of this Division dictates otherwise. Fill, vent, and circulate system while increasing temperature. Drain and refill system. Clean all strainers and check valves, etc. before refilling. Inspect each run of each system for completion of joints, supports and accessory items. Remove start up strainers and leave for owner's inspection.
- B. Inspect pressure piping in accordance with procedures of ASME B31.1 or ASME B31.9, as applicable. Owner reserves the right to perform radiographic inspections of welded joints in pressure piping.

3.04 PIPING TESTS

- A. Test pressure piping in accordance with ASME B31.1 or ASME B31.9, as applicable. Minimum test pressure shall be 1-1/2 times the normal operating pressure or 100 psi, whichever is greater, unless otherwise indicated.
- B. Notify Owner at least 24 hours in advance of pressure test to allow for Owner observation. If Owner is not properly notified, contractor shall repeat pressure test in Owner's presence.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS AND RELATED WORK SPECIFIED ELSEWHERE:

A. Related Documents

1. Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions, Division-01 Specification sections, other Division 23 specification sections, and Division 26 specifications apply to work of this section.

B. Summary

1. This Section includes, packaged, factory-fabricated and assembled, gas-fired, fire-tube, sealed combustion, condensing boilers, trim, and accessories for generating heating hot water. The boilers shall be designed for operation in the condensing mode to extract the latent heat from the combustion products.

1.02 SUBMITTALS

1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, venting, and accessories.
 - a. Include plans, elevations, sections, details, and attachments to other work.
 - b. Wiring Diagrams: Power, signal, and control wiring.
3. Source quality-control test reports: Indicate and interpret test results for compliance with performance requirements.
4. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements.
5. Warranty: Special warranty specified in this Section.
6. Close-out Submittals: Operation and Maintenance Data for boilers to include in emergency, operation, and maintenance manuals.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code Section IV.
- C. ANSI Compliance: The boiler shall be certified and listed under the latest edition of ANSI Z21.13, Gas Fired Low Pressure Steam and Hot Water Boilers.
- D. Fuel Gas Code, NFPA 54, ANSI Z223.1.
- E. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

- F. AHRI Compliance: Boilers shall be AHRI listed and must meet the minimum efficiency specified under AHRI BTS-2000 as defined by Department of Energy in 10 CFR Part 431.
- G. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- H. Gas Train, Burner Safeguards, and Controls shall be fully compliant with ASME CSD-1, Controls and Safety Devices for Automatically Fired Boilers.
- I. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- J. UL 1738: Standard for Safety Venting Systems for Gas Burning Appliances, Category IV venting with AL 29-4C vent material.
- K. Boilers shall be factory test fired prior to shipment. Manufacturer shall supply certified test fire report which shall include fuel/air settings and combustion test results.

1.04 WARRANTY

Boiler manufacturer shall guarantee in writing that equipment will be free from defects and agree to repair or replace components of boilers that fail in materials or workmanship within a specified warranty

A. Warranty Period for Fire-Tube Condensing Boilers

- a. Heat Exchanger, Pressure Vessel and Condensate Collection Basin shall carry a 10-year limited warranty, from date of startup, against defects in materials or workmanship and failure due to thermal shock.
- b. All other components shall carry a one-year warranty from date of boiler startup or substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with all requirements, provide the product indicated on Drawings or a comparable product by one of the following
 - 1. Lochinvar Crest
 - 2. Fulton
 - 3. AERCO

2.02 MANUFACTURED UNITS – CONSTRUCTION

- A. Description: Boilers shall be natural gas fired, fully condensing, and fire-tube design. The boilers shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with stainless-steel heat exchanger sealed pressure tight, stainless steel combustion chamber, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

- B. Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 30,000 to 40,000 Btu’s per tube. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or “O” rings in the heat exchanger design. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.
- C. Condensate Collection Basin: Shall be fully welded 316L stainless steel.
- D. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.
- E. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 2.4 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 94 gallons.
- F. Burner: Natural gas, forced draft single burner premix design with an upper and lower chamber supplied by individual combustion systems. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall have an independent laboratory rating for Oxides of Nitrogen (NOx) to meet requirements of South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 (FB1500-FB2000), San Diego Air Control Pollution District as compliant with Regulation 69.2.1 (FB1500-FB5000), Bay Area Quality Management District as compliant with Regulation 9 Rule 7 (FB1500-FB5000) and Texas Commission on Environmental Quality (FB1500-FB2000) as being compliant with Section 117.465.
- G. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.
- H. Gas Train: The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of the following minimum turndowns: Turndown 25:1, Minimum Input 60,000, Maximum Input 1,500,00
- I. Casing:
 - 1. Jacket: Heavy gauge steel jacket, with snap-in or interlocking closures with baked enamel or powder coated finish.
 - 2. Minimum 2 inch thick 1/2-inch thick, mineral-fiber insulation surrounding the heat exchanger.
 - 3. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 4. Combustion-Air Connections: Inlet and vent duct collars.
- J. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- K. Characteristics and Capacities:

1. Heating Medium: Hot water.
2. Design Water Pressure Rating: 160 psi working pressure.
3. Safety Relief Valve Setting: 50 psig
4. Minimum Water Flow Rate: 25 gpm

2.03 GAS TRAIN:

- A. Gas Train, Burner Safeguards, and Controls shall be UL and FM approved, fully compliant with ASME CSD-1, Controls and Safety Devices for Automatically Fired Boilers and GE GAP (formerly I.R.I.).
- B. The gas train shall include manual shutoff valve, gas inlet trap, gas regulator rated for 2 PSIG inlet pressure, and safety shutoff gas valve(s).
- C. The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of the following minimum turndowns:

2.04 TRIM

- A. ASME Section IV Safety Relief Valve. Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
- B. Pressure and Temperature Gages: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range. There shall be temperature gauge on supply and return side of the boiler.
- C. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- D. Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium

2.05 BURNER AND COMBUSTION CONTROLS (FIRING BY NATURAL GAS):

- A. Gas Train, Burner Safeguards, and Controls shall be fully compliant with ASME CSD-1, Controls and Safety Devices for Automatically Fired Boilers.
- B. Combustion safeguard and control package and less than 30 PPM, Low NOx natural gas burner with variable speed combustion blower to supply optimum combustion air and shall include:
 1. Gas pilot shutoff
 2. High and low gas pressure switches
 3. Air pressure switch.
 4. UL approved flame safeguard. Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
 5. Blower to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 6. Control compartment Enclosures: NEMA 250, Type 1A.
 7. The combustion control system shall provide a minimum turndown ration of 25:1 per ANSI Z21.13 over the input range from high to low fire.

2.06 CONTROLS

- A. Boiler manufacturer to provide a fully functional micro processor controller. The controller shall be capable of staging boilers for optimum efficiency and operating lead lag as

necessary. Heating hot water controls shall be enabled upon external signal through the RS232 modbus interface to the BAS. The boiler shall be capable of inputting a start stop and hot water reset signal from the boiler control panel in the event the boiler plant controller fails

- B. The boiler microprocessor control system shall seamlessly communicate and interface with the building control system (BAS). The MCS shall be provided with all equipment necessary for external communications utilizing BACNet interface or gateway. The interface shall provide to the BAS full monitoring of all parameters and functions available through the boiler's microprocessor control system. All hardware, software, documentation, and operational parameters needed for this interface shall be provided.
- C. Boiler controls shall feature a standard, factory installed 8" LCD screen display with the following standard features:
 - 1. Variable Speed Boiler Pump Control: Boiler may be programmed to send a 0-10V DC output signal to an ECM or VFD boiler pump to maintain a designed temperature rise across the heat exchanger. The boiler shall be able to operate in this mode with a minimum temperature rise of 20 degrees F and a maximum temperature rise of 60 degrees F.
 - 2. Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
 - 3. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
 - 4. Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
 - 5. Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
 - 6. Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
 - 7. Domestic hot water priority: Boiler shall make the domestic hot water call for heat a priority over any space heating call and adjust the boiler setpoint to the domestic hot water boiler setpoint.
 - 8. Domestic hot water modulation limiting: Boiler may be programmed to limit the maximum domestic hot water firing rate to match the input rating of the indirect tank coil.
 - 9. Domestic hot water night setback: Boiler may be programmed to reduce the domestic hot water tank set point during a certain time of the day.
 - 10. PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
 - 11. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
 - 12. Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
 - 13. Three pump control: Boiler shall have the ability to control the boiler pump, system pump and the domestic hot water pump.

14. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
 15. Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.
 16. Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.
 17. Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.
 18. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
 19. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.
- D. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:
1. Lead lag:
 2. Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
 3. Front end loading:
 4. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours. Delete paragraph above and retain first two paragraphs and associated subparagraphs below if controls are components of boilers. Coordinate with Division 23 Section "Instrumentation and Control for HVAC."
- E. Boiler operating controls shall include the following devices and features:
1. Set-Point Adjust: Set points shall be adjustable.
 2. Operating Pressure Control: Factory wired and mounted to cycle burner.
 3. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
 4. Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 10 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.
- F. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.

2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 4. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
 5. Proof of Closure Valve (FB 6000 only): Proof of closure valve (POC) shall prevent the boiler from firing if the POC valve seat is detected open. Upon a call for heat, once the POC valve seat is proven to be closed, the pre-purge cycle will begin and the POC valve will begin to open.
 6. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
 7. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
 8. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.
- G. Building Automation System Interface: Factory installed Modbus BACnet IP gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.

2.07 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
- B. Electrical Characteristics: See Boiler Schedule.

2.08 VENTING OF BOILERS

- A. Category IV venting in compliance with NFPA 54.
- B. Exhaust flue must be Category IV approved PVC or AL 29-4C inner/430SS outer sealed vent material from one of the approved manufacturers listed in the boilers Installation and Operation manual. Boilers exhaust vent length must be able to extend 100 equivalent feet.
- C. Intake piping must be approved material as listed in the Installation and Operations manual. Boilers intake pipe length must be able to extend to 100 equivalent feet.
- D. Vent system shall be supplied from a single manufacturer and shall include vent piping and fittings, roof thimble, cone flashing, and rain cap. Vent connections shall be made by factory built in seal.
- E. Boilers shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.
- F. Vent and intake systems will be separate for each boiler and shall be installed in accordance with manufacturer's installation instructions.

2.09 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code. Boiler shall be rated for 160 PSIG working pressure.
- C. Provide source quality test report with shipped unit.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER INSTALLATION (By Installation Contractor)

- A. Installation shall be in full accordance with the manufacturer's recommendations. The equipment manufacturer's factory installed wiring shall be fully coordinated with field wiring. All safety devices, interlocks, etc. required by the Specifications and Drawings and as recommended by the equipment manufacturer shall be provided.
- B. Modifications in piping, valving, controls, accessories, and arrangement from that indicated and required for integration of the unit proposed into the system as designed shall be the responsibility of the Installation Contractor.
- C. Install boilers level on concrete base.
- D. Install gas-fired boilers according to Fuel Gas Code NFPA 54, ANSI Z223.1.
- E. Assemble and install boiler trim.
- F. Install electrical devices furnished with boiler but not specified to be factory mounted.
- G. Install control wiring to field-mounted electrical devices.
- H. Facilitate work by, and provide assistance to the manufacturer's representative.

3.03 CONNECTIONS (By Installation Contractor)

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.

- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23.
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Boiler Venting:
 - 1. Sealed combustion. Vertical flue and combustion air intake to outside. Maintain separation between combustion air intake and flue as per manufacturer's specifications.
 - 2. Connect full size to boiler connections.
 - 3. NFPA 54, ANSI Z223.1 Category IV venting. Vent material in contact with combustion products shall be stainless steel, AL29-4C or PVC.
 - 4. Special listed UL-1738 vent shall be installed in accordance with vent manufacturer's instructions.
- I. Ground equipment according to Division 26.
- J. Connect wiring according to Division 26.

3.04 FIELD QUALITY CONTROL (By Furnishing Contractor)

- A. Perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, startup, and to assist in testing. Provide manufacturer's representative for startup and testing. Technician to assist with setting up proper operation of the BACnet interface. Confirm temperature reset algorithm.
- C. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
 - 5. Remove and replace malfunctioning units and retest as specified above.

6. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide visit to site and on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

D. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire to 100% percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Engineer in advance of test dates.
8. Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report.
9. Document test results in a report and submit to Engineer.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 23 52 16

DIVISION 26

ELECTRICAL

PART 1 - GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. All work, materials, etc., shall be furnished and installed, whether or not specifically shown on the drawings and/or called for in the specifications, which may be necessary to comply with all of the requirements, due to the exigencies of the work, to complete the work and the contract in a satisfactory and approved manner.
- B. The work to be done under this contract shall consist of furnishing all equipment, labor, materials required for the items listed in the proposal, and/or as shown on the contract drawings, together with all devices, connectors, splices and appurtenances, required for a safe, clean, complete and ready for service, reliable, substantial and rugged working installation, to the satisfaction of the Engineer and to execute the intent of this contract and these specifications.
- C. The Contractor shall be responsible for determining the proper connection points for all power, control, and signal wiring installed under this contract, regardless of whether the connection points are in equipment furnished under this contract, existing equipment, or equipment furnished by others. The Contractor shall include in his bid prices any field surveys, wire tracing or other work required to ascertain the proper connection points for all wiring.
- D. It is the intent of these specifications that the Contractor shall furnish equipment and material which is suitable for the purpose and for installation in the location as is.
- E. It is also the intent of the specification that the equipment, materials and accessories, as furnished, shall be complete in all respect and ready to operate.
- F. The specifications cover the general design, construction arrangement, and certain particular features, but do not purport to cover all details entering into the design of the equipment and accessories.
- G. Minor revisions in construction details will be made to accommodate equipment proposed and approved on the drawings thereof, submitted by the Contractor. Major revisions shall not be made nor shall equipment be submitted for approval which cannot be installed in structures of the approximate dimensions and character specified herein.
- H. Further, it is also the intent of these specifications to provide a complete contract including items which may be omitted or not shown but which are considered normal and accepted engineering practice for this type of contract at no additional cost to the Owner.
- I. All work shall be done in a thorough and workmanlike manner and shall conform to the best modern practice in the manufacture and installation of high-grade equipment and materials. Wherever possible, all parts shall be made according to standard gauge to facilitate replacement and repair.

- J. All materials furnished under these items shall be the best of their respective kinds and shall be free from defects in design and workmanship.
- K. All materials or equipment not meeting the specified requirements shall be rejected, and shall be replaced at once by the Contractor with materials or equipment of the specified type and quality, at no cost to the Owner.
- L. All materials for which no detailed specifications are given herein shall be of the quality and character best adapted and suitable for the purpose for which they are to be used and shall be subject to the approval of the Engineer.
- M. Where any material or article or the maker or distributor thereof is specified by name, this is done for the purpose of more clearly describing the type or quality desired. Any material or article of equal quality, merit and performance, in the opinion of the Engineer, will be acceptable, if approval is given in writing.
- N. All materials furnished and work done by the Contractor shall be subject to the inspection of the Engineer. Defective materials shall be removed from the site of the work and defective work repaired or replaced as directed. Facilities for handling and inspection of materials and equipment and for access to the work in progress shall at all times be furnished by the Contractor.
- O. Where any delay is encountered in carrying out work due to unfavorable operating conditions, the Contractor shall not be entitled to additional compensation therefore, but the time allowed equivalent to the period of actual delay.

1.02 DESCRIPTION OF WORK

- A. Work includes all labor and electrical labor and equipment to install the project as represented in the drawings and specifications.
- B. Unless specifically dimensioned, the work shown on the drawings is diagrammatic, and is intended only to show general arrangement.
- C. Include in the work, all accessories and devices necessary for the intended operation or perfection of any system, whether or not specifically shown or specified.
- D. The term "Furnish" shall mean to obtain and supply to the job site. The term "Install" shall generally mean to fix in position and connect for use. Where language indicates that one party or trade is to "install" and another is to "connect", the term "install" shall mean only to fix in position, and "connect" shall mean to make electrical connections to. The term "Provide" shall mean to furnish and install.
- E. Furnish all documentation, such as shop drawings, as-built drawings, and operation and maintenance manuals, certify and perform all required testing as herein specified.
 - 1. Testing & Start-Up: Assist MC in startup of all equipment. Provide As-Built Documentation, start-up and test protocol.
 - 2. As Built Documentation: Provide a minimum of (4) sets of Ring Binders per each system with the following minimal content:
 - a. Electrical As Built Drawings
 - b. Equipment Data/Specification sheets and Operating Manuals and fuse sizes by equipment.

c. List of lighting lamps by fixture

F. Provide all items as called out in "Scope of Work" on drawings.

1.03 STANDARD OF QUALITY

A. The specifications establish the standards of quality required, either by description or by references, to brand name, name of manufacturers or manufacturer's model number. All materials shall be new unless noted otherwise.

B. Where one product only is specifically identified by name or manufacturer's model number, the Contractor shall base his bid on the use of the named product. Where multiple names are used, the Contractor shall base his bid on the use of any of those products named.

C. The Contractor may submit, with his bid, the names of products which are proposed as substitutions for products named in the specifications. Each proposed substitution shall be accompanied by a written sum of money to be added or deducted from his bid. The Owner reserves the sole right to accept or reject said substitutions with or without cause.

D. When equipment and/or materials are proposed to be purchased from a manufacturer other than those specified, the Contractor shall provide complete data adequate for the Engineer's evaluation of the proposed substitution.

E. When the equipment other than that specified is used, the Contractor shall be responsible for any extra cost of required revisions such as structural steel, concrete, electrical, piping, etc. Such additional costs shall be identified at the time such substitutions are proposed.

1.04 SUBMITTALS

A. Engineer's review of shop drawings is solely for the benefit of the Owner and in no way relieves the contractor from his obligations to furnish materials which satisfy the requirements of his contract and the design intent.

B. Shop drawings, product data and samples shall be submitted as required by the General Conditions or Project Requirements and as supplemented by this section.

C. When a specific specification section identifies that no submittal is required, the contractor shall provide the specified materials without submittals.

D. Provide to the Engineer, a schedule of shop drawing submissions identifying submittal target dates.

E. The Contractor shall review, approve and submit shop drawings, with promptness so as to cause no delay in his work or in that of others. No submissions will be accepted by the Engineer without the signed review and approval of the Contractor.

F. The Contractor shall check and verify pertinent field measurements, and quantities of equipment and materials required.

G. Submittals shall be identified by reference to the drawing(s), section(s) of specifications, or equipment symbols to which they relate.

H. Shop drawings, when required, shall include:

1. Verification of information given in Contract Documents such as performance, dimensions, weight, materials, construction, types, models, manufacturer, etc.
 2. Equipment layouts drawn to scale as may be required.
 3. Wiring diagrams and schematics for equipment.
 4. Any special construction conditions.
 5. Other information/data as may be requested.
- I. All submittals shall identify the specific details of the product or assembly. All optional features being provided or proposed shall be so noted or the submittal will be rejected.
- J. The Engineer will return submittals with one of the following notations stamped thereon; REVIEWED, REVIEWED AS NOTED, REVISE AND RESUBMIT, REJECTED or SUBMIT SPECIFIED ITEM AND THE FOLLOWING:
1. Review is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for:
 - a. dimensions which shall be confirmed and correlated at the job site
 - b. fabrication processes and techniques of construction
 - c. coordination of his work with that of all other trades
 - d. the satisfactory performance of his work.
 2. The work involved may proceed when submittals are marked REVIEWED or NO EXCEPTIONS TAKEN with no further submission required.
 3. The work involved may proceed when submittals are marked REVIEWED AS NOTED, providing corrections are made and submittals are resubmitted for record. Review does not authorize changes to Contract Sum unless stated in a separate letter or Change Order. In the event that any notes placed on the submittals by the Engineer are believed to result in a change in the Contract Sum, the Engineer shall be notified immediately and fabrication may not be undertaken until written authorization to proceed is issued by the Owner.
 4. The work involved may not proceed when submittals are marked REVISE AND RESUBMIT. Submittals must be corrected and resubmitted for review.
 5. Submittals marked REJECTED OR SUBMIT SPECIFIED ITEM are not in accordance with the Contract Documents and require a new submittal for review.
 6. For items being resubmitted, clearly identify changes made from the initial submittal requested by the Engineer. The Engineer will review only those changes requested and identified by the Contractor.

1.05 PROTECTION OF WORK

- A. Each Contractor is responsible for the protection of his materials, equipment, and completed work as defined in the General or Project Requirements and as supplemented herein.
- B. All openings into any part of the conduit systems, all fixtures and equipment must be securely covered or otherwise protected to prevent damage due to dropped tools or materials, work by others or intrusion of grit, dirt, water, snow, ice or other foreign matter. Remove burrs, dirt, paint spots and debris. The Contractor shall be held responsible for all damage done to unprotected work or materials.

1.06 STEEL AND CONCRETE WORK FOR ELECTRICAL EQUIPMENT

- A. Steel: Provide all miscellaneous steel supports and anchors required for equipment and materials installed under this Specification. Manual of Construction by American

Institute of Steel Construction latest edition shall be followed in design and construction except that the second sentence of paragraph 4.2.1., Section 4 of Division 5, page 5-177 will not apply. Structural steel members shall conform to ASTM A36, and shall have a shop applied coat of rust inhibiting paint. Welding of steel shall conform to American Welding Society, Standard Code for Arc and Gas Welding in Building Construction. Bolts, nuts and washers for structural steel framing and concrete embedment shall be high tensile type minimum 3/4" diameter conforming to ASTM A325. Slotted-steel channel supports shall have flange edges turned toward web, and 9/16 inch diameter slotted holes at a maximum 2 inches o.c., in webs.

- B. Channel depth: 2-1/2 inches minimum.
- C. Channel thickness: selected to suit structural loading.
- D. Fittings and Accessories: Products of the same channel manufacturer.
- E. Channel supports and fittings shall be hot dip galvanized steel.
- F. Concrete work and anchors: Refer to for concrete work and anchors.

1.07 COUNTERFLASHING

- A. Where conduits or other items pass through any roof, wall or other exterior component, provide counter flashing as required.

1.08 EQUIPMENT BY OTHERS

- A. Summary of Work, together with other technical sections in the Project Manual, describe equipment that will be furnished by the Owner or from other sources.
- B. The responsibility for setting, installation and protection of such equipment will be defined in other sections of the Project Manual.
- C. Provide services rough-in for and make final connections to this equipment as shown and specified.
- D. Provide coordination to assure clearances required for moving equipment to final location.

1.09 MOVING OF EQUIPMENT

- A. Verify that electrical equipment will pass through all restricting openings, and when equipment or sections of equipment are larger than these openings, install this equipment prior to construction of enclosing walls, floors or roofs.
- B. Use planking or cribbing as required to protect adjoining construction from damage.
- C. Provide rigging and expert rigging personnel as required for equipment installation in difficult locations. Rigging shall include any necessary structural investigation and temporary structural support.

1.10 CUTTING AND PATCHING

- A. Provide all openings through walls, floors and ceilings, etc. required for the installation of

work defined on the drawings and specifications.

- B. Following installation and testing, restore floors, walls and ceilings with materials equal to the original construction and finish to match existing surfaces.
- C. Cutting and patching shall be performed only by tradesmen familiar with the construction involved.

1.11 IDENTIFICATION

- A. Nameplates:
 - 1. Provide each new normal power load break switch, automatic transfer switch, starter, circuit breaker, panel, remote start-stop station, pilot light or safety switch with an engraved laminated black and white phenolic nameplate, white letters on black background.
 - 2. Provide Fire Alarm panels with an engraved laminated red and white phenolic nameplate, white letters on red background.
 - 3. Compose the legend so as to clearly indicate the function of the equipment. Letters and numbers to be at least 3/16 inch high.
 - 4. Locate the nameplate in a position so as to be clearly visible and secure with screws. Rivets and adhesives are not acceptable.
 - 5. Submit proposed nameplate legend for review.
 - 6. Provide a nameplate on the main switchgear indicating names of the electrical contractor and the engineer and project year.

1.12 FINAL ACCEPTANCE

- A. The Contractor shall perform and complete work in accordance with the Contract Documents without fault or defect of any kind. In the absence of more specific directives, the work shall:
 - 1. be completed in a first class manner.
 - 2. be placed in a thoroughly clean and unmarred condition.
 - 3. be checked out in a step-by-step manner to ascertain that fastenings, controls, parts, safety devices, operating devices and other required appurtenances have been provided in accordance with the Contract Documents.
 - 4. be free of previously condemned or rejected parts and be properly restored to an acceptable condition.
 - 5. be adjusted for proper operation wherever adjustments or calibrations exist in the work.
- B. All systems shall be operated to demonstrate that the requirements of the Contract have been met and that the systems have been adjusted and will operate in accordance therewith.

1.13 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish for review, three hard bound copies of complete written instructions for the operation, care and maintenance of each piece of equipment and/or system. Include recommended frequency of inspection, cleaning, oiling, greasing, and adjustment and other action as may be required in accordance with manufacturer's recommendations. Material shall include manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, service organizations, etc.

1.14 PERMITS, FEES AND CERTIFICATES OF APPROVAL

- A. Contractor shall acquire all permits and certificates. Submit a final inspection certificate from Middle-Atlantic Inspections or other NFPA affiliated agency with request for final payment.
- B. Contractor shall provide all power, labor and instruments required for tests and cleaning of systems.
- C. Whenever tests are required, three (3) copies of the test reports shall be submitted to the Engineer.
- D. Tests may be observed by the Engineer or his representative. Notify the Engineer a minimum of three weeks in advance of test dates.

1.15 COMPLIANCE WITH CODES, STANDARDS AND REGULATIONS

- A. In the absence of specific instruction in the technical specifications, equipment and installation shall conform to the following applicable codes, standards and regulations, latest editions:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American National Standard Institute (ANSI)
 - 3. Underwriter's Laboratories, Inc. (UL)
 - 4. American Welding Society Code (AWSC)
 - 5. NFPA 70, "National Electrical Code", latest edition
 - 6. National Electrical Manufacturer's Association (NEMA).
 - 7. Occupational Safety and Health Act (OSHA).
 - 8. National Fire Protection Association (NFPA).
 - 9. National Electrical Safety Code (NESC)
 - 10. North Carolina Building Code, latest edition
 - 11. Institute of Electrical and Electronics Engineers (IEEE)
 - 12. Illuminating Engineering Society of North American (IESNA)
 - 13. State and Local Building, Electric, and Fire Codes and Regulations.

1.16 PAINTING

- A. Cabinet trims and similar prefabricated equipment shall be factory primed and finish painted with baked enamel in color selected. This equipment shall not be painted in the field unless the factory finishes have been marred or as otherwise directed. Do not paint over UL or similar labels or mechanical/electrical nameplates.

1.17 COORDINATION OF WORK

- A. Coordinate installation of conduit runs and equipment with other trades and conditions in the building and participate in all coordinated shop drawings. Variance from work shown on drawings will be subject to approval. Where interference occurs and electrical work is directed to be relocated, provide such relocation without additional cost.
- B. It is the Electrical Contractor's responsibility to coordinate with the manufacturers of all new and existing pieces of equipment the different aspects of their interfaces. All additional costs for equipment manufacturer's redesign of interfaces caused by the EC's failure to properly coordinate all aspects of the interfaces shall be borne by the EC.

1.18 ACCESS PANELS

- A. Furnish access panels where required, to concealed pull boxes, junction boxes, or similar equipment located above dry wall board ceiling or behind walls. Installation of access panels shall be by mechanics of the pertinent trade under General Construction.
- B. Access panels shall be 18" x 18" minimum, 16 gage wall or ceiling frame and a 14 gage panel door with not less than 1/8" fire proofing secured to the inside of the door.
- C. The door shall be provided with concealed hinges and cylinder lock, and prime-coated steel prepared for painting. Each door shall be capable of opening 180 degrees.
- D. Doors for wall panels shall be secured with suitable clips and counter sunk tamperproof screws.
- E. Access panels shall have "label" fire rating equal to the ceiling or wall surface.

1.19 WARRANTY

- A. The contractor and equipment manufacturers shall jointly guarantee all wiring and equipment to be free of defects in workmanship and material for a period of one year from the date of final acceptance, unless otherwise noted.

1.20 PROJECT RECORD DOCUMENTS

- A. Maintain at job site, one copy of record documents and samples as required under the General Conditions of the Contract, including Drawings, Specifications, Addenda And Bulletins, Change Orders, Shop Drawings, Product Data and Samples, Field Orders, Field Test Records and Maintenance and Operating Manuals.
- B. Provide files and racks for storage of documents. Maintain documents in a clean, dry legible condition and in good order. Do not use record documents for construction purposes. Make record documents and samples available during normal working hours for inspection.
- C. Recording:
 - 1. Label each document "Project Record" in neat large letters and provide final completion date.
 - 2. Record information concurrently with construction progress.
 - 3. Do not conceal any work until required information is recorded.
- D. Record Drawings - legibly mark to record actual construction as follows:
 - 1. A print set (blue-line or black-line) of contract drawing or shop drawing mark-ups of actual installations which vary substantially from the work as originally shown. Mark whichever drawing is most capable of showing "field" condition fully and accurately; however, where shop drawing are used for mark-up, record a cross reference at corresponding location on working drawings. Mark with red erasable pencil and, where feasible, use other colors to distinguish between variation in separate categories or work. Mark-up new information which is recognized to be of importance to Owner, but was for some reason not shown on either contract drawings or shop drawings. Give particular attention to concealed

- work which would be difficult to measure and record at a later date. Note related change order numbers where applicable.
2. Record Specifications and Addenda, Bulletins, Requests for Information (RFI's) and Construction Clarification Sketches (CSK's) - legibly mark each Section to record:
 - a. Any variations in actual work in comparison with text of specifications
 - b. modifications as issued. Give particular attention to substitutions, selection of options, and similar information where work is concealed or cannot otherwise be readily discerned at a later date by direct observations. Note related record drawing information and product data, where applicable.
 - c. Changes made by Field Order or by Change Order.
- E. Product Data: Maintain one copy of each product data submittal, and mark-up significant variation in actual work in comparison with submitted information.
1. Include both variations in product as delivered to site, and variations from manufacturer's instruction and recommendations for installation.
 2. Give particular attention to concealed products and portions of the work which cannot otherwise be readily discerned at a later date by direct observations. Note related change orders and mark-up of record drawings and specifications.
- F. Record Drawings Submittal at Project Completion: Organize record drawing sheets into manageable sets, bind with durable paper cover sheets and print suitable titles, dates and other identification on cover of each set. Transfer marking required by previous paragraphs to set of reproducible transparencies. Submit complete set of transparencies to the Design Professional and two sets of blue-line prints.
- G. Product Data Submittal at Project Completion: Submit three sets of marked-up product data submittals for record purposes that include resolution of all review notes and field revisions.
- H. Miscellaneous Record Submittals: Refer to other sections of these specifications for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the works. Immediately prior to date(s) of substantial completion, complete miscellaneous records and place in good order properly identified and bound or filed, ready for continued use and reference. Submit to Architect/Engineer for Owner's records.
- I. Maintenance Manuals: Organize maintenance-and-operating manual information into three suitable sets of manageable size, and bind into individual binders properly identified and indexed (thumb-tabbed). Include:
1. emergency instructions
 2. spare parts listing
 3. warranties
 4. wiring diagrams
 5. recommended "turn-around" cycles
 6. inspection and cleaning procedures
 7. recommended frequency of testing, adjustment and any other maintenance requirements
 8. shop drawings
 9. product data
 10. similarly applicable information.

- J. Bind each manual of each set in heavy duty 2-inch, vinyl-covered ring binder, and include pocket folders for folded sheet information. Mark identification on both front and spine for each binder

END OF SECTION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.03 SUBMITTALS

- A. No submittals.

1.04 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70, 2011
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 – PRODUCTS

2.01 RACEWAY AND CABLE LABELS

- A. Color: Black letters on orange field.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend over-laminated with a clear, weather- and chemical-resistant coating.
- C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
- D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (0.08 mm thick by 25 to 51 mm wide).
- F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- G. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

2.02 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396-inch (1-mm) galvanized steel backing; and with colors, legend, and size required for the application. 1/4 inch (6.4-mm) grommets in corners for mounting.
- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.03 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength: 50 lb (22.3 kg) minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.
 - 1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
 - 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
 - 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
 - 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. Install painted identification according to manufacturer's written instructions and as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime surfaces using type of primer specified for surface.
 - 3. Apply one intermediate and one finish coat of enamel.
- F. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 - 1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
 - 3. Apply the following colors to the systems listed below:
 - a. Fire Alarm System: Red.
 - b. Fire-Suppression Supervisory and Control System: Red and yellow.
 - c. Combined Fire Alarm and Security System: Red and blue.
 - d. Security System: Blue and yellow.
 - e. Mechanical and Electrical Supervisory System: Green and blue.
 - f. Telecommunication System: Green and yellow.
- G. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- H. Circuit Identification Labels on Boxes: Install labels externally.
 - 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 - 2. Concealed Boxes: Plasticized card-stock tags.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- I. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder, and branch-circuit phase conductors:
 - 1. 208/120-V Conductors:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue
 - 2. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.

- b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- J. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to the indicated circuit designations.
 2. Tag Fasteners: Nylon cable ties.
 3. Band Fasteners: Integral ears.
- K. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- L. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
- M. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high lettering on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Disconnect switches.
 4. Enclosed circuit breakers.
 5. Motor starters.
 6. Remote-controlled switches.
 7. Control devices.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:
 - 1. Qualifications of testing agencies and their personnel.
 - 2. Suitability of test equipment.
 - 3. Calibration of test instruments.
 - 4. Coordination requirements for testing and inspecting.
 - 5. Reporting requirements for testing and inspecting.
- B. Electrical tests and inspections specified in various Division 26 and 28 Sections shall be provided with the contract by the appropriate manufacturer's reps. and electrical contractor.

1.03 QUALITY ASSURANCE

- A. Testing Agency Qualifications: As specified in each Section containing electrical testing requirements and in subparagraph and associated subparagraph below.
 - 1. Independent Testing Agencies: Independent of manufacturers, suppliers, and installers of components to be tested or inspected.
 - a. Testing Agency's Field Supervisor for Power Component Testing: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Division 16 power component Sections.
- B. Test Equipment Suitability: Comply with NETA ATS, Section 5.2.
- C. Test Equipment Calibration: Comply with NETA ATS, Section 5.3.

PART 2 - NOT USED

PART 3 - EXECUTION

3.01 GENERAL TESTS AND INSPECTIONS

- A. If a group of tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:
 - 1. Perform insulation-resistance tests on all service and feeder cables.

2. Perform continuity tests.
3. Perform rotation test (for motors to be tested).
4. Provide a stable source of single-phase, 240/120-V electrical power for test instrumentation at each test location.
5. Provide service ground resistance test, see 260510.

B. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:

1. Manufacturer's written testing and inspecting instructions.
2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
3. Tabulation of expected measurement results made before measurements.
4. Tabulation of "as-found" and "as-left" measurement and observation results.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.03 SUBMITTALS

- A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.04 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled" as defined in NDPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

- B. Comply with NFPA 70.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.06 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 CONDUCTORS AND CABLES

A. Manufacturers:

1. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Rome Cable Company.

- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

- C. Conductor Material: Copper complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

- D. Conductor Insulation Types: Type THHN-THWN, XHHW and XHHW-2 complying with NEMA WC 5 or 7.

- E. Multiconductor Cable: MC/Armored cable with ground wire.

- F. NM cable is not permitted.

- G. Aluminum alloy wires are allowed in 100 Amp and larger feeders with use of crimp connectors and conductive, anti-corrosive termination grease.

2.03 CONNECTORS AND SPLICES

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.01 CONDUCTOR AND INSULATION APPLICATIONS

- A. Underground Service Entrance: Type XHHW-2, single conductors in raceway. Aluminum alloy conductors, with crimp termination lugs and conductive termination grease, is allowed.

- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, or XHHW single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or flexible metal conduit where permitted for connections to devices not exceeding 3' in length. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- G. Branch circuit homeruns exposed or concealed: Type THHN-THWN, single conductors in EMT or RMC.
- H. Flexible metal conduit shall be used at all equipment locations subject to vibration. Length shall not exceed 6' for power feeds and 36" for control devices.
- I. Multiconductor Cable: MC/Armored cable is permitted only for whips to lighting fixtures, fishing in to individual devices in existing walls where EMT installation is not feasible, and where specifically approved by the Engineer or Architect.

3.02 INSTALLATION

- A. Conceal conduits in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 260500 Section "Common Work Results."
- F. Seal around cables penetrating fire-rated elements according to Division 078400 Section "Firestopping."
- G. Identify and color-code conductors and cables according to Division 260075 Section "Electrical Identification."

3.03 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.04 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 3 Concrete for exterior ductbanks, manholes, and underground utility concrete work.
 - 2. Division 078400 Section "Firestopping" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 3. Division 260500 Section "Common Work Results" for supports, anchors, and identification products.
 - 4. Division 262726 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.03 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible metal conduit.
- G. RMC: Rigid Metal Conduit.

1.04 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.06 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 METAL CONDUIT AND TUBING

- A. Manufacturer:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co. /Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- D. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.03 METAL WIREWAYS

- A. Manufacturer:
 - 1. Hoffman.
 - 2. Square D.
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R.

- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Screw cover type, Flanged and gasketed type at exterior.
- F. Finish: Manufacturer's standard enamel finish.

2.04 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard grey finish coat.
 - 1. Manufacturer:
 - a. Walker Systems, Inc.; Wiremold Company (The).
 - b. Wiremold Company (The); Electrical Sales Division.
- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.05 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturer:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. Emerson/General Signal; Appleton Electric Company.
 - 3. Erickson Electrical Equipment Co.
 - 4. Hoffman.
 - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - 6. O-Z/Gedney; Unit of General Signal.
 - 7. RACO; Division of Hubbell, Inc.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Com.; Adalet-PLM Division.
 - 10. Spring City Electrical Manufacturing Co.
 - 11. Thomas & Betts Corporation. Walker Systems, Inc.; Wiremold Company
 - 12. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Floor Boxes: Cast metal, fully adjustable, rectangular.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.06 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components: provide manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: For raceway, enclosure, or cabinet components: provide manufacturer's standard gray paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors:
 1. Exposed: Rigid steel or IMC.
 2. Concealed: Rigid steel or IMC.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 4. Boxes and Enclosures: NEMA 250, Type 3R or 4.
- B. Indoors:
 1. Exposed: EMT.
 2. Concealed: EMT.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 4. Damp or Wet Locations: Rigid steel conduit.
 5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4.
 6. Where subject to damage, use rigid steel or IMC.
- C. Minimum Raceway Size: 3/4-inch.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz.

3.02 INSTALLATION

- A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water

- pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
 - C. Support raceways as specified in Division 260510 Section "Common Work Results."
 - D. Install temporary closures to prevent foreign matter from entering raceways.
 - E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
 - F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
 - G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
 - H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to rigid steel conduit, or IMC before rising above the floor.
 - I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
 - J. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
 - K. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

- L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- M. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller. In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- N. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- O. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- P. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- Q. Set floor boxes level and flush with finished floor surface.
- R. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- S. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- T. Flexible Metal Conduit may only be used in existing walls or for short, 6' max., connections to equipment or lights.
- U. All conduit to be run concealed except where specifically reviewed and approved by owner.
- V. All boxes shall be recessed wherever feasible.

3.03 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.04 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 26 04 10
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes individually mounted enclosed switches and circuit breakers, rated 600 V and less, used for disconnecting and protection functions.
- B. See Division 16 Section "Fuses" for fuses for fusible disconnect switches.

1.02 SUBMITTALS

- A. Product Data: For each type of switch and circuit breaker indicated.
- B. Shop Drawings: Include wiring diagrams for shunt-tripped circuit breakers.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Source Limitations: Obtain switches and circuit breakers through one source from a single manufacturer.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corp.; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Square D Co.
 - 4. Bussmann; Power Module Switch.

2.02 ENCLOSED SWITCHES

- A. Enclosed, Non-fusible Switch: NEMA KS 1, Type GD, with lockable handle, interlocked with cover.

- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type GD, with clips to accommodate specified fuses, and lockable handle, interlocked with cover.

2.03 ENCLOSED CIRCUIT BREAKERS

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 4. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

2.04 ENCLOSURES

- A. Listed for environmental conditions of installed locations, including:
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Food Service Areas: NEMA 250, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Temporary Provisions: Remove temporary lifting provisions and blocking of moving parts.
- B. Identify components; provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods."

3.02 FIELD QUALITY CONTROL

- A. Testing: After installing disconnect switches and circuit breakers and after electrical circuits have been energized, demonstrate product capability and compliance with requirements.

- B. Inspections and Tests for Switches and Circuit Breakers: Make internal and external inspections and perform tests, including the following:
1. Inspect for freedom from physical damage, proper unit rating, mechanical condition, enclosure integrity, cover operation, unit anchorage, clearances, and tightness of electrical connections. If a loose electrical connection is observed on any unit, check each electrical connection for each switch and circuit breaker with a torque wrench for compliance with manufacturer's torquing instructions.
 2. Test insulation resistance of each pole, phase-to-phase, and phase-to-ground, following manufacturer's written instructions. Test insulation resistance of shunt trip circuits. Use 500-V minimum test voltage for units and circuits rated up to 250 V, 1000-V minimum test voltage for units rated more than 250 V. Measured insulation resistance must be 25 megohms, minimum, for switches rated up to 250 V, and 100 megohms, minimum, for switches rated more than 250 V.
 3. Test cover and other interlocks and interlock release devices for proper operation.
- C. Additional Inspections and Tests for Switches: Include the following:
1. Inspect for proper rating and fuse provisions.
 2. Check adequacy and integrity of fuse-holders by removing and installing fuses.
 3. Check integrity of phase barriers.
 4. Inspect blade alignment visually while operating switch to observe adequacy of blade pressure.
- D. Additional Inspections and Tests for Circuit Breakers: Include the following:
1. Inspect for proper frame, trip, and fault current interrupting rating.
 2. Test shunt trip devices, circuits, and actuating components for proper operation.
- E. Correct defective and malfunctioning units on-site, where possible, and re-inspect and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Concrete equipment bases.
 - 3. Cutting and patching for electrical construction.
 - 4. Touchup painting.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.04 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
- B. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- A. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.
- B. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to existing transformer.
- D. Coordinate installation and connection of exterior underground utilities and services.
- E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."
- F. Coordinate electrical connections by mechanical contractor. Reference mechanical specification 230530, Section 1.2.

PART 2 – PRODUCTS

2.01 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for use outdoors or in damp locations: Hot-dip galvanized steel.
- C. Slotted Steel Channel Supports: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of 2 inches o.c., in webs.
 - 1. Channel Thickness: Selected to suit structural loading.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- F. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- G. Expansion Anchors: Carbon steel wedge or sleeve type.
- H. Toggle Bolts: All steel springhead type.

2.02 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.01 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.02 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot dip galvanized materials or nonmetallic, U channel

system components.

- B. Dry Locations: Steel materials.
- C. Selection of Supports: Comply with manufacturer's written instructions.
- D. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.03 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze or bracket type galvanized hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. All exposed support equipment shall be galvanized.

- N. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
1. Wood: Fasten with wood screws or screw type nails.
 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 3. New Concrete: Concrete inserts with machine screws and bolts.
 4. Existing Concrete: Expansion bolts.
 5. Light Steel: Sheet metal screws.
 6. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof test load.

3.04 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing fire-stopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.05 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
1. Supporting devices for electrical components.
 2. Cutting and patching for electrical construction.
 3. Touchup painting.

3.06 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."
1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats
 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish.
- B. Remove burrs, dirt, paint spots, and construction debris.
- C. Protect equipment and installations and maintain conditions to ensure that coatings,

finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

- D. Protect all open device boxes from painter's sprays.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467.

PART - PRODUCTS

2.01 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 260120 Section "Conductors and Cables."
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Bare Copper Conductors: Comply with the following:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Assembly of Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

- F. Copper Bonding Conductors: As follows:
1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- G. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.02 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic welded type in kit form and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
 2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.

3.02 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install an insulated green copper equipment ground in all branch circuits and feeders.

3.03 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Conductors shall be in EMT conduit, bond conduit at both ends with

approved bonding bushings and #6.

- B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- C. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

3.04 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturers published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- F. Compression Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following: Single and duplex receptacles, including ground fault circuit interrupters.
 - 1. Single and double pole snap switches.
 - 2. Device wall plates.
 - 3. Floor service outlets.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.
- C. Field quality control test reports.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.05 COORDINATION

- A. Receptacles for Owner Furnished Equipment: Match plug configurations, minimum of NEMA 20 Amp.
- B. Cord and Plug Sets: Match equipment requirements, minimum of NEMA 20 Amp.

PART 2 - PRODUCTS

2.01 RECEPTACLES

- A. Straight Blade Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- B. Straight Blade and Locking Receptacles: Heavy Duty grade, 20 Amp.
- C. GFCI Receptacles: Straight blade, non-feed through type, heavy Duty grade, with integral

NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- deep outlet box without an adapter.

- D. Receptacles shall have separate hex-head grounding screw terminals.
- E. Special purpose receptacles to match NEMA designations of various manufacturers' plugs.

2.02 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber insulated, stranded copper conductors, with Type SOW- jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable clamping jaws. Match cord and receptacle type for connection.

2.03 SWITCHES

- A. Single, Double Pole, or 3 Way Switches: Comply with DSCC W-C-896F and UL 20.
- B. Snap Switches: Heavy Duty grade, quiet type, 20 Amp.
- C. Switches shall have separate hex-head grounding screw terminals.

2.04 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Brushed Stainless Steel.
 - 3. Material for Unfinished Spaces: Galvanized steel, with rolled edges to match box size.
 - 4. Material for Wet Locations: Thermoplastic with spring-loaded lift-cover, and listed and labeled for use in "wet locations" and "raintight while in use".

2.05 FINISHES

- A. Color:
 - 1. Wiring Devices Connected to Normal Power System: Grey, unless otherwise indicated or required by NFPA 70.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
- C. Remove wall plates and protect devices and assemblies during painting.

- D. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.02 IDENTIFICATION

- A. Comply with Division 26 Section "Electrical Identification."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.03 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements. Test GFCI receptacle operation with both local and remote fault simulations according to manufacturer's written instructions. Operation of the GFCI trip shall not interrupt power to any other receptacle on circuit unless otherwise noted.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION
