



Company Name:

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PURCHASING DEPARTMENT

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VOLUME 2 – TECHNICAL SPECIFICATIONS

RFB NO. 2023-028

**PROJECT MANUAL
FOR
REPLACE ROOFTOP MULTI-ZONE UNITS**

**BIDS DUE JANUARY 5, 2023
2:00 P.M. CST**

*Technical Specifications Prepared by
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Fort Worth, TX 76116*

RFB NO. 2023-028



Scope Summary

To: Bidders

From: Les Brown, PE

Date: October 20, 2022

Subject: Tarrant County Resource Connection Replace Rooftop Multizone Units

Remove existing Rooftop Multizone Units and replace with new Rooftop Multizone Units per the Drawings and Specifications.

1. The Mechanical Contractor for this project will be the Prime Contractor and will be responsible for ALL work on the project. The Mechanical Vendor will need to acquire ALL required subcontractors that are needed to complete all elements of the work. This will include, but not be limited to: Electrical work, Piping work, General Construction work, and Controls work.
2. Perform all work in accordance with all applicable National and Local Codes and Code Authorities.
3. Submit electronic copy of Shop Drawings for all materials furnished under this work.
4. Secure and pay for all necessary permits, licenses and inspections required by Law for the completion of the work. Secure and pay for all certificates of approval that are required and deliver them to the Engineer before final acceptance of the work.
5. Examine the project site and make allowances in the Bid to accommodate existing conditions.
6. All material shall be new, UL listed, and free from defects, unless existing material is specifically shown to be reused. Install all material in accordance with good workmanship standards.
7. Requests for substitutions of specified material must be submitted to Tarrant County Purchasing Department as a Pre-Bid question.
8. Provide factory finish on all material furnished to the jobsite and touch up finishes which have been damaged.

9. The schedule for removing existing units and installation of replacement units shall be carefully coordinated and scheduled with Tarrant County Facilities Management prior to any work. The County's intent is that each building remain occupied with normal weekday activity schedules. For Base Bid anticipate that all work will be performed during regular hours, 7:00 am to 5:00 pm Monday thru Friday. For Alternate Bid anticipate that all work will be performed after hours, 5:01 pm to 6:59 am Monday thru Friday, or anytime Saturday, Sunday.
10. All equipment and accessories will be new.
11. Provide all electrical work required to support the new equipment in conformance with NEC requirements.
12. Any roofing alteration work will be discussed and approved by the County's Roofing Contractor, Rooftech. Contact Shawn Clark, ph 817-496-4631 x115 or 682-301-3806.
13. All Controls work will be provided and installed by Enviromatic Systems. The costs for all Controls work will be included in the bid. Contact Sid Ellis, ph 972-206-2590.
14. All Testing and Balancing work will be provided by the County's TAB Contractor, Air Balancing Company, and will be contracted direct to the County. TAB costs will not be included in the bid.

TABLE OF CONTENTS

DIVISION 22 - PLUMBING

22 10 00 PLUMBING PIPING

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

23 00 10 BASIC MECHANICAL REQUIREMENTS
23 05 06 MECHANICAL DEMOLITION
23 05 12 MECHANICAL AND ELECTRICAL COORDINATION
23 09 23 BUILDING AUTOMATION SYSTEM (BAS)
23 31 13 METAL DUCTWORK
23 74 13 MULTIZONE ROOFTOP HEATING AND COOLING UNITS

DIVISION 26 - ELECTRICAL

26 05 10 GENERAL REQUIREMENTS FOR ELECTRICAL WORK
26 05 11 WORK IN EXISTING BUILDING
26 05 12 MECHANICAL AND ELECTRICAL COORDINATION
26 05 19 WIRES AND CABLES
26 05 20 WIRE CONNECTION AND DEVICES
26 05 26 GROUNDING
26 05 27 SEALING OF PENETRATIONS
26 05 29 SUPPORTING DEVICES
26 05 32 PULL AND JUNCTION BOXES
26 05 33 CONDUITS
26 05 34 OUTLET BOXES
26 28 16 OVERCURRENT PROTECTIVE DEVICES
26 28 17 DISCONNECT SWITCHES
26 29 13 MOTORS, MOTOR STARTERS AND CONTROLS



10/20/22

SECTION 22 10 00

PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of Plumbing Piping Work required by this section is indicated on Drawings and by requirements of this section.
- B. Types of Plumbing Piping systems specified in this section include the following:
 - 1. Miscellaneous Drain Lines
 - 2. Natural gas system.

1.2 REFERENCES

- A. ANSI/ASME B16.18 - Cast Copper Alloy Solder - Joint Pressure Fittings.
- B. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- F. ANSI/ASME Sec. 9 - Welding and Brazing Qualifications.
- G. ANSI/ASTM B32 - Solder Metal.
- H. AWS D10.12 - Recommended Practices and Procedures for Welding Plain Carbon Steel Pipe.
- I. AWS D10.9 - Qualifications and Procedures for Piping and Tubing Welding.
- J. AWS B3.0 - Welding Procedure and Performance Qualification.
- K. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- L. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- M. ASTM B88 - Seamless Copper Water Tube.
- N. ASTM B306 - Copper Drainage Tube (DWV).
- O. NFPA 54 - National Fuel Gas Code, latest edition.

1.3 QUALITY ASSURANCE

- A. Plumbing Certification: Persons performing plumbing work shall have a current State Plumbing License.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Conform to ASME Code and AWS 10.12.
- D. Welders Certification: In accordance with ANSI/ASME Sec. 9 or AWS D1.1, AWS D10.9, and AWS B3.0, as applicable.
- E. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer.

1.4 REGULATORY REQUIREMENTS

- A. Conform to the most recent editions of the applicable City codes and ordinances and NFPA 54.
- B. Piping materials specified herein are acceptable products to the Architect, but all are not necessarily acceptable to applicable local codes and ordinances. It is the responsibility of the Contractor to provide materials, from the options listed herein, that are acceptable to both the Architect and applicable local codes and ordinances.

1.5 SUBMITTALS

- A. Submit product data on pipe materials, fittings, valves and accessories in accordance with Division 01 and Section 22 00 10.
- B. Submit shop drawings and piping layout in accordance with Division 01 and Section 22 00 10.
- C. Submit certificates as listed below to Architect in accordance with Division 01 and Section 22 00 10.
 - 1. Test Certificates of Approval for Piping Systems.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 MISCELLANEOUS DRAIN PIPING

- A. Condensate Drain Piping:
 - 1. Copper pipe; ASTM B306, DWV fittings; ANSI/ASME B16.3, cast bronze, or AWSI/ASME B16.29, wrought copper. Joints: ANSI/ASTM B32, solder, Grade 50B.

2. Mechanically pressed copper fittings are acceptable for pipe sizes 1/2 in. through 4 in. diameter. Operating pressure: 200 PSI CWP Max, Temperature range: -20°F to 250°F. Fittings shall conform with ASME B16.18, ASME B16.22 or ASME B16.26, and performance criteria of IAPMO PS-117 or ASME B16.51. Fittings shall utilize a factory installed EPDM sealing element. The installer shall be trained and certified by the fitting manufacturer. Copper press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer. Acceptable products are Apollo Press, Viega ProPress or Mueller Industries Streamline PRS.

2.2 NATURAL GAS PIPING

- A. Natural gas piping, above grade.
 1. Steel Pipe: ASTM A53 or A120, Schedule 40 black. Fittings: ANSI/ASME B16.3, malleable iron, or ASTM A234, forged steel welding type. Joints: Screwed for pipe two in. and under; ANSI/AWS D1.1, welded, for pipe over two in.

PART 3 - EXECUTION

3.1 PIPING

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- E. Route piping in orderly manner and maintain gradient.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Slope water piping and arrange to drain at low points.
- H. Temporarily plug or cap open ends of pipe at the end of each workday.
- I. Install vented U-type drain trap on all draw-thru cooling coil drain pans.
- J. Gas piping connections to equipment will be rigid pipe with dirt leg and union. Flexible gas whips will not be allowed.

3.2 PIPING CONNECTIONS

- A. Threaded Connections
 1. Threaded joints shall be in accordance with ANSI B1.20.1. Threaded joints shall be made up Teflon tape or lead free pipe joint compound applied to the male thread only. Should a joint be loosened after being made up, it shall not be made up a second time unless the threads are cleaned and new compound applied.

2. All steel piping which is assembled with screwed joints shall have exposed threads thoroughly primed with a coat of lead free rust resistant paint. Paint immediately after installation. This shall apply to both piping that is to be covered as well as uncovered.

B. Soldered Connections

1. Soldered joints shall be in accordance with ASTM B32. Flux shall be nonacid type. Remove composition discs from solder end valves during soldering. Pipe ends, fittings and valves shall be properly cleaned before soldering and wiped clean to remove flux and excess solder after soldering.

C. Copper Press Connections:

1. Mechanical copper press fittings shall be made in strict accordance with the manufacturer's installation instructions.
 - a. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.

3.3 FLANGES AND UNIONS

- A. Provide flanges and unions at all final connections to equipment, and traps. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shut-off valves.
- B. All flanged connections shall be in accordance with ANSI B16.5 for steel flanges and ANSI B16.1 for cast iron flanges.
- C. Bolting shall be in accordance with ASTM A307 Grade B with bolts and nuts in accordance with ANSI B18.2.1 and ANSI B18.2.2.
- D. Tighten flange bolts in sequence 180° directly opposite each to equal tension.
- E. Flanges and unions shall be made of same material or compatible material as piping systems in which they are installed.

3.4 TESTING

- A. General: Furnish pumps, gauges, equipment and personnel required, and test as necessary to demonstrate the integrity of the finished installation.
- B. Natural Gas: Pneumatically test and make tight at 1-1/2 times the normal operating pressure and not less than 5 psi. Retain for four hours. Repair all leaking joints and retest.
- C. Tests and test procedures shall be witnessed and approved by the Owner's Representative.
- D. After completion and approval of testing, submit "Test Certificates of Approval" for gas piping systems stating that all test results are satisfactory. Certificates of approval must be signed by Contractor.

END OF SECTION

SECTION 23 00 10

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS AND SUPPLEMENTAL GENERAL PROVISIONS

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

1.2 GENERAL

- A. The Contractor shall provide all plans, labor, equipment, appliances and materials, and shall perform all operations in connection with the installation of the mechanical work in accordance with the Specifications, applicable drawings, and the conditions specified above.
- B. Contractor shall provide all equipment required and usually furnished in connection with such work and systems whether or not specifically mentioned or specifically indicated on the drawings.

1.3 INSPECTION OF THE SITE

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

1.4 PERMITS, UTILITY CONNECTIONS, AND INSPECTIONS

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

1.5 APPLICABLE CODES AND STANDARDS

- A. The installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of the Specifications, except as may be hereinafter modified in these Specifications and associated drawings.

- B. Latest edition of the National Fire Protection Association Standards (NFPA):
 - 1. NFPA No. 70 National Electrical Code
 - 2. NFPA No. 90A Installation of Air Conditioning and Ventilating systems
 - 3. NFPA No. 101 Safety to Life from Fire in Buildings and Structures
 - 4. NFPA No. 255 Test of Surface Burning Characteristics of Building Materials
- C. United States of America Standards Institute (ASA) Standards:
 - 1. A40.8 National Plumbing Code
 - 2. B31.1 & B31.1a Code for Pressure Piping
- D. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes.
- E. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.
- F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) 1985: All applicable manuals and standards.
- G. Air Moving and Conditioning Association (AMCA): All applicable manuals and standards.
- H. American Society of Testing and Material (ASTM): All applicable manuals and standards.
- I. American Water Works Association (AWWA): All applicable manuals and standards.
- J. National Electrical Manufacturer's Association (NEMA): All applicable manuals and standards.
- K. City Fire Department as applicable to construction of this site.
- L. City and State Building Codes.
- M. State of (Texas) Occupational Safety Act: Applicable safety standards.
- N. Occupational Safety and Health Act (OSHA).
- O. State of (Texas) Energy Conservation Construction Code.
- P. All work shall be in accordance with all regulations and requirements of the State of Texas Architectural Barriers Act (TAS) and the Americans with Disabilities Act (ADA).
- Q. Refer to Specifications sections hereinafter bound for additional codes and standards.
- R. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. All material shall be listed by the Underwriter's Laboratories, Inc., as conforming to its standards and so labeled in every case where such a standard has been established for the particular type of material in question.

- S. All equipment provided and all installation methods shall meet all applicable requirements of the Fort Worth Energy Code, State Energy Code, or International Energy Conservation Code.
- T. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by other specifications of the Contract Documents, providing no work or fabrication of materials has been accomplished in a manner of non-compliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.6 CONTRACT DOCUMENTS

- A. These specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, switch controls, circuits, lines, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.
- B. If the Contractor deems any departures from the drawings necessary, details of such departures and the reasons therefore shall be submitted to the Architect for review. No departures shall be made without prior written acceptance.
- C. There are intricacies of construction that are impractical to specify or indicate in detail; however, in such cases the current rules of good practice and applicable specifications shall govern.
- D. It is the Contractor's responsibility to properly use all information found on the Mechanical drawings where such information affects his work.
- E. All dimensional information related to new structures should be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.
- F. The interrelation of the specifications, the drawings, and the schedules is as follows: The specifications determine the nature and setting of the several materials, the drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics.
- G. Should the drawings or specifications disagree within themselves, or with each other, the better quality of greater quantity of work or materials shall be estimated upon, and unless otherwise directed by the Engineer and Owner's Representative in writing, shall be performed or furnished. Figures indicated on drawings govern scale measurements and large-scale details govern small-scale drawings.

1.7 SPACE AND EQUIPMENT ARRANGEMENT

- A. The size of fire protection, plumbing, mechanical, and electrical equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other

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

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

1.8 FABRICATION DRAWINGS

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

1.9 SUPERVISION

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

1.10 EXISTING FACILITIES

- A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in-service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, and remove all such temporary protection upon completion of the work. All barricades and safety devices shall be in compliance with OSHA.
- B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.
- C. Outages of services, as required by the new installation, will be permitted only at a time approved by the Engineer and Owner's Representative.

1.11 DEMOLITION AND RELOCATION

- A. The Contractor shall modify, remove and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities.
- B. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed and sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Engineer and Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas of facilities, which must remain in operation during the construction period, shall not be interrupted without prior specific approval of the Engineer and Owner as hereinbefore specified.
- C. All equipment and materials indicated to be removed and not be re-used shall be disposed of by the Contractor.

1.12 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall prepare, in triplicate for the Owner's Manual, complete sets of operating and maintenance instructions, system piping, valving, control and interlock diagrams, manuals, parts lists, etc., for each item of equipment. Include copies of all equipment warranties.
- B. In addition, the Contractor shall provide the services of a competent technician to instruct the Owner in the complete and detailed operation of all equipment and systems. These instructions shall be provided for a period of not less than 4 hours to fully accomplish the desired results. Upon completion of these instructions, a letter of release will be required, stating the dates of instruction and the personnel to whom instructions were given. The Contractor shall be responsible for proper maintenance until the instructions have been given to the Owner's maintenance personnel.

1.13 GUARANTEE

- A. All work and equipment shall be guaranteed for a period of one year from the date of substantial completion.
- B. Guarantee shall be for all labor and materials.
- C. Certain items for equipment shall have additional or extended warranties when so specified.

1.14 MATERIALS AND WORKMANSHIP

- A. All materials, unless otherwise specified, shall be of current U.S. manufacture, new, free from all defects, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall present a neat, workmanlike appearance. Materials, and/or equipment damaged in shipment, or otherwise damaged

prior to installation, shall not be repaired at the job site, but shall be replaced with new materials and/or equipment.

- B. The responsibility for furnishing the proper equipment and/or material, and to see that it is installed as intended by the manufacturer rests entirely upon the Contractor, who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.15 FLAME SPREAD PROPERTIES OF MATERIALS

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

1.16 CONSTRUCTION REQUIREMENTS

- A. The Mechanical plans and specifications including the General Provisions, Supplemental General Provisions, and other pertinent documents issued by the Engineer, are a part of these specifications and the accompanying mechanical drawings, and shall be complied with in every respect. All the above is included in the Contract Documents, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of architectural, structural and electrical details from the mechanical drawings.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.
- C. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation supplied by the manufacturer of the equipment to be installed and thereby to provide an integrated satisfactory operating installation.
- D. The mechanical and associated drawings are necessarily diagrammatic in character and cannot show every connection in detail or every pipe or equipment in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate pipe hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- E. When the mechanical drawings do not give exact details as to the elevation of pipe, ducts, etc., physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Piping and duct systems

are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner, and the plans do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas. Piping specified to be insulated shall be supported in a manner that will allow the insulation to be installed without gaps. Insulated piping in concealed areas shall be offset with fittings as necessary to permit installation of insulation. Bending of pipes or installing pipes in a strain in order to insulate will not be permitted.

1.17 MECHANICAL SUBMITTALS

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

1.18 PRODUCT OPTIONS AND SUBSTITUTIONS

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

Materials	Physical size
Workmanship	Weight
Gauges of Materials	Appearance
Available Local Service Personnel	Performance
Previous successful installations	Capacity
Delivery Schedules	Required Equipment Clearances

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

1.19 RECORD DOCUMENTS

- A. Refer to the Division 01 Section: "CLOSEOUT PROCEDURES" for requirements. The following paragraphs supplement the requirements of Division 01.
- B. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned for column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.20 PAINTING

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

1.21 CLEANING

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

1.22 MOTORS AND DRIVES

- A. Motors:
 - 1. General: Motors shall be U/L-approved, with copper windings, and with a minimum Service Factor of 1.15. The nominal capacity shall exceed the brake horse-power requirements at duty schedules.
 - 2. Motors 1/2 HP and smaller shall be 120-volt, single-phase with internal overload protection.
 - 3. Motors 3/4 HP and larger shall be 208/230 or 460 -volt, 3-phase, unless scheduled or noted otherwise, and shall have thermal over-load cutouts in each phase as recommended by the motor manufacturer.
 - 4. Motors shall be as manufactured by Century, General Electric, US Motors, Wagner, Westinghouse, or approved equal.
- B. Drives:
 - 1. Belt drives shall be rated for 150% of motor-rated horsepower.
 - 2. Drive assemblies up to two (2) belts shall have adjustable motor sheaves with the mid-point of the adjustment range at the RPM required for the specified performance.
 - 3. On drive assemblies with 3 or more belts, provide fixed motor sheaves for the specified RPM. Provide and install up to 2 pulley changes as necessary to achieve the required air quantities.
 - 4. All multiple-belt drives shall be factory-marked-matched sets.
- C. Specific requirements:
 - 1. Provide high-efficiency motors for the following:
 - a. Air-Handling Units, as scheduled.
 - b. Ventilating Fans, as scheduled.
 - c. HVAC Pumps, as scheduled.
 - 2. Efficiency ranges shall be as follows:

Nominal HP	Minimum Efficiency	Premium Efficiency
3	86.5	89.5

5	87.5	89.5
7.5	88.5	91.7
10	89.5	91.7
15	91.0	92.4
20	91.0	93.0
25	91.7	93.6
30	92.4	93.6
40	93.0	94.1
50, 60, 75	93.0, 93.6, 94.1	94.5, 95.0, 95.4
100	94.1	95.4

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

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

- A. The manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer's materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Engineer and Owner's Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturer's directions and shall obtain the Engineer and Owner's Representative instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Engineer and Owner's Representative, he shall bear all costs arising in connection with the deficiencies.
- B. The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.
- C. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions.
- D. Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriter's Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under these sections of the specifications conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.
- E. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Observation.
- F. Standard factory finish will be acceptable on equipment specified by model number; otherwise surfaces of ferrous metal shall be given a rust-inhibiting coating. The treatment shall withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking, and no signs of rust creepage beyond 1/8 in. on either side of the scratch mark. Where rust-inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable, unless a specific coating is specified, except that

coal tar or asphalt type coatings will not be acceptable, unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-6215.

- G. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts located so that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.
- H. The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Engineer and Owner's Representative of any discrepancy before performing any work. Adjustments to the work required, in order to facilitate a coordinated installation, shall be made at no additional cost to the Owner.

2.2 PROTECTION

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

2.3 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

- A. Each trade, subcontractor and/or contractor must work in harmony with the various other trades, subcontractors, and/or contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or contractor must pursue his work promptly and carefully as not to delay the general progress of the job. This Contractor shall work in harmony with contractors working under other contracts on the premises.

2.4 PRECEDENCE OF MATERIALS

- A. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structural design of the building, which will fit into the available space, and which will insure complete and satisfactory systems. Each Contractor shall be responsible for the proper fitting of his material and apparatus into the building.
- B. Each Contractor shall so harmonize his work with that of the other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping the

other trades. Piping interferences shall be handled by giving precedence to pipelines that require a stated grade for proper operation.

PART 3 - INSTALLATION

3.1 INSTALLATION METHODS

- A. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces. Where conflicts occur, the Contractor shall meet with all involved trades and the Engineer and Owner's Representative and resolve the conflict, prior to erection of any work, in the area involved.

3.2 ROOF PIPING SUPPORTS

- A. Single run pipe 2-1/2 in. O.D. and less, shall have Type SS8-C or SS-8R as manufactured by PHP Systems/Design, or an approved equal, spaced at a maximum 8 ft. o.c. and installed on roof pads if required by Roofing Manufacturer. Use roller support for all straight piping lengths of 50 ft. or greater. All piping on fixed support shall be strapped to support channel. Coordinate exact locations of supports with Roofing Contractor. Do not use wood blocking under supports.
- B. Provide adjustable height threaded rod assembly supports as manufactured by MAPA Products model MS-1/MS-1-E or equal for supporting roof mounted condensate drain piping for pipe up to 2 in. Supports shall consist of a reinforced nylon support base, clamped pipe support bracket, and an adjustable threaded rod height assembly. A neoprene pad shall be adhered to the base. Install per manufacturer's instructions. Coordinate exact locations of supports with contractor.

3.3 FABRICATION OF PIPE

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

3.4 IDENTIFICATION AND LABELING

- A. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them.
- B. All items of mechanical and electrical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16 in. thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1 in. high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include, but not be limited to, the following:
 - 1. Rooftop units

3.5 TESTS AND INSPECTIONS

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

3.6 COOPERATION AND CLEANUP

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

3.7 CLEANING AND PAINTING

- A. This Contractor shall thoroughly clean the finish on all parts of the materials and equipment with factory applied finishes. Such surfaces shall be carefully wiped and all cracks and

corners scraped out. If the finish has been damaged, the Contractor shall re-paint to the satisfaction of the Engineer and Owner's Representative.

- B. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during painting operation.

3.8 ELECTRICAL PROVISIONS OF MECHANICAL WORK

- A. The extent of electrical provisions to be provided as mechanical work is indicated in other mechanical sections of the specifications, on the drawings and as further specified in this section.
- B. Wherever possible, match the elements of the electrical provisions of mechanical work with similar elements of the electrical work specified in electrical sections of the specifications.
- C. Standards:
 - 1. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards to definitions of terminology herein.
 - 2. Comply with National Electrical Code (NFPA No. 70) for installation requirements.
 - 3. Comply with National Electrical Contractors Association (NECA) "Standard of Installation".

3.9 TEMPORARY FACILITIES

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

3.10 EQUIPMENT INSTALLATION REQUIREMENTS

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

END OF SECTION

SECTION 23 05 06

MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Demolition of:
 - 1. Multizone Rooftop Units
 - 2. All other appliances or devices associated with equipment or devices to be removed.
- B. Demolition of power wiring and conduit from each mechanical item to be removed, back to the point of connection.

1.2 QUALITY ASSURANCE

- A. Perform all demolition and removal work necessary to arrive at the arrangement shown on the Contract Drawings.
- B. Perform all operations in such a method to cause minimum damage to items to be relocated, salvaged, or to remain intact and in use.

1.3 JOB CONDITIONS

- A. Perform site repair and removal of salvaged items at times approved by the Owner. Accomplish repair and removal of items in a continuous and diligent manner in order to limit interference with Owner's on-going operations.
- B. Drawings may not indicate and specifications may not identify every item required to be moved or removed.
- C. Before submitting bids, visit and examine the site of the work and become familiar with the scope of the work and the details of the demolition work to be accomplished.
- D. Submittal of a bid will be evidence that such an examination has been made and the various details noted.
- E. Claims for extra compensation because of additional labor, materials, or equipment required because of difficulties encountered, will not be recognized unless items were concealed at time of inspection of the Contract Documents. Bring all such items to the attention of the Owner's Representative and the Engineer and Owner's Representative for their disposition before continuing with the work.
- F. Execute demolition work in a manner to protect adjacent equipment and other existing items against damage.
- G. Provide and erect lights, barricades, warning signs, and other items as required for protection of the Owner's employees, building occupants, and the public.

- H. Control the dust resulting from demolition to prevent it from spreading the occupied areas of the building and to avoid creating a nuisance in the immediate surrounding area.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 PROTECTION

- A. Provide protection for all building elements, all items which are to remain, all occupants and all workers at all times, and in accordance with all requirements of the Owner.

3.2 PROTECTION OF BUILDING FROM THE WEATHER

- A. Maintain weather protection for the space(s) being worked in at all times, and in accordance with all requirements of the Owner.

3.3 DEMOLITION

- A. Perform demolition in accordance with all requirements of the Owner.

3.4 DISPOSITION OF MATERIALS

- A. Dispose of all demolition items and materials in a legal off-site location.

3.5 CLEANING

- A. Section 23 00 10 - Basic Mechanical Requirements.

3.6 REMOVAL OF WATER

- A. Be responsible for the removal of water in areas in which scheduled work is to be performed.
 1. Remove water by pumping, siphoning, absorbent mopping, or compressed air brooming.
 2. Do not use any method of removal that will cause damage to new or reused adjacent equipment or materials.

3.7 SCHEDULING

- A. Schedule demolition in strict compliance with the Owner's instructions.

3.8 DISCONNECTION AND RECONNECTION OF UTILITIES

- A. Do not disconnect or reconnect any utilities until notifying the Owner's Representative.
- B. Notify the Electrical Contractor when requiring Electrical Disconnect or Reconnect.

END OF SECTION

SECTION 23 05 12

MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 WORK INCLUDED

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

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

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

	ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
27.	Alarm bells or horns for fire protection (sprinkler) system	21	21	28
28.	Generator (underground) fuel tank	22	22	--
29.	Generator fuel level indicator	22	22	26
30.	Generator fuel piping from tank to generator	22	22	--
31.	Underground fuel tank leak detection and monitoring system	22	22	22

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

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

C. PRECEDENCE

1. In general, piping systems that require a stated grade for proper operation shall have precedence over other systems.
2. Precedence for pipe, conduit and duct systems shall be as follows.
 - a. Building lines
 - b. Structural members
 - c. Soil and drain piping
 - d. Vent piping

- e. Steam piping
- f. Condensate piping
- g. Refrigerant piping
- h. Electrical bus duct
- i. Supply ductwork
- j. Return ductwork
- k. Exhaust ductwork
- l. Chilled water and heating water piping
- m. Automatic Fire Protection Sprinkler Piping
- n. Natural gas piping
- o. Domestic hot and cold water piping
- p. Electrical conduit

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

D. FINAL INSPECTION AND REPORT

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

END OF SECTION

SECTION 23 09 23

BUILDING AUTOMATION SYSTEM (BAS)

PART 1 - GENERAL

1.1 GENERAL

- A. All work shall be in accordance with Division 01 and Section 23 00 10 "BASIC MECHANICAL REQUIREMENTS".
- B. This work is to modify/replace the existing BAS controls to support the new replacement multizone rooftop units. Work should include providing all controls for the complete operation of the new multizone units, including the hot deck and cold deck control. Closely coordinate requirements with unit manufacturer.
- C. All Building Automation System work shall be equal in quality, functionality and performance to the Reliable Controls system utilized in other Tarrant County facilities. Reliable Controls - Installed by Enviro-matic Systems.

1.2 SCOPE OF WORK

- A. Furnish all labor, materials, tools, equipment, and services for a fully integrated Building Automation System (BAS) as indicated, in accordance with the Contract Documents.
- B. The BAS shall fully integrate third-party manufacturers control subsystems (i.e., boilers, chillers, etc.), which shall be capable of operating in a standalone mode, while being software integrated to comprise the complete BAS.
- C. Deliver the following features, hardware, and functions as a minimum:
 - 1. One Application Specific Controller (ASC) for each air-handling unit, packaged rooftop unit, make-up air unit, fan coil unit, etc.
 - 2. Integration to third-party manufacturers' microprocessor controllers, as specified herein.
 - 3. Furnish and install all sensors, transducers, and controlled devices per this specification.
 - 4. All monitoring, controlling, optimizing, interfacing, reporting, archiving, operator interface and information formulation and other special packages as required by the Contract Documents, including but not limited to the following:
 - a. Scheduled stop/start.
 - b. Optimum start/stop.
 - c. Run time totalization.
 - d. Duty cycling.
 - e. Power demand control.
 - f. Load restoration following a fire alarm.
 - g. Automatic alarm lockout.
 - h. Password access control.
 - i. Graphics display.
 - j. Dynamic graphical trending.
 - k. Historical data recording and reporting.

1.3 CONTRACTOR QUALIFICATIONS

- A. An integrated BAS will only be considered for acceptance from the following companies that are able to demonstrate that hardware and software they provide are equal in quality and performance to the Tarrant County standard BAS provider - Reliable Controls.
 - 1. Reliable Controls – Installed by Enviro-Matic Systems – Contact Sid Ellis
972-206-2590
- B. The BAS shall be installed by competent mechanics and commissioned by competent technicians regularly employed by the equipment vendor.
- C. Provide installation, calibration, and check-out of the stand-alone subsystems; as well as the complete operation of the integrated BAS, including graphics generation, implementation of point history feature and energy management applications.
- D. Maintain local support facility with technical staff, spare parts inventory, and all necessary test diagnostic equipment.

1.4 REFERENCED STANDARDS, CODES, AND ORDINANCES

- A. It is the responsibility of the Contractor to be familiar with all codes, rules, ordinances, and regulations of the authority having jurisdiction and their interpretations that are in effect at the site of the work.
- B. All systems equipment, components, accessories, and installation hardware shall be new and free from defects and shall be UL listed where applicable. All components shall be in current production and shall be a standard product of the system or device manufacturer. Refurbished or reconditioned components are unacceptable. Each component shall bear the make, model number, device tag number (if any), and the UL label as applicable. All system components of a given type shall be the product of the same manufacturer.

1.5 SUBMITTALS

- A. Provide submittal data as referenced in Division 01 and Section 23 00 10 of these Contract Documents.
- B. Shop drawings shall include the installation details for all equipment to be furnished or provided under this Contract. At minimum, the shop drawings shall include details of:
 - 1. BAS architecture schematic (riser diagram).
 - 2. Interconnection and installation drawings and schedules, including bill of materials and sequences of operation.
 - 3. Field panel layout, plan location and interconnection drawings and specification sheets.
 - 4. Proposed panel loading and spare capacity.
 - 5. Location and sizes for sleeves in walls and floors.
 - 6. Instrumentation locations marked on Mechanical Drawings.

7. Schematic of monitored/controlled systems indicating device locations.
 8. Device installation details.
 9. Other documentation as appropriate.
- C. Product data submittals shall include the specifications for all equipment and software to be furnished or provided under this Contract. In addition, the submittals shall include details of:
1. Software and special packages.
 2. Computer equipment and terminal specification sheets.
 3. Field sensors and instrumentation specification sheets.
 4. Damper, valve and actuator specifications sheets.
 5. Proposed graphic schematics of mechanical and other systems.
 6. Wiring specifications.
 7. Format of point/function log sheet.
 8. Other documentation as appropriate.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

- A. The BAS shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, lighting control, information management, and historical data collection and archiving as well as trending.
- B. The BAS shall consist of the following:
 1. Network Control Panels (NCPs)
 2. Application Specific Controllers (HVAC, TUC, etc.)
- C. System shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, Network Control Panels, and operator devices.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each NCP and ASC shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection as well as trending. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- E. Network Control Panels shall be able to access any data from, or send control commands and alarm reports directly to, any other controller on the network without dependence upon a central processing device, such as a central file server. Network Control Panels shall also be able to send alarm reports to multiple operator workstations, terminals, and printers without dependence upon a central processing device or file server.

2.2 NETWORKING/COMMUNICATIONS

- A. The design of the BAS shall network Operator workstations (fixed and portable) and Network Control Panels. Inherent in the system's design shall be the ability to expand or modify the network.
- B. Local Area Network
 - 1. Workstation/Network Control Panel Support. Operator workstations and NCPs shall directly reside on a single shared high-speed local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.
 - 2. Dynamic Data Access. All operator devices, either network resident or connected via the internet, shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.
 - 3. General Network Design. Network design shall include the following provisions:
 - a. High-speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices.
 - b. Support of any combination of controllers and Operator workstations directly connected to the local area network.
 - c. Detection and accommodation of single or multiple failures of workstations, NCP, or the network media. The network shall include provisions for automatically reconfigure itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
 - d. Message and alarm buffering to prevent information from being lost.
 - e. Error detection, correction, and re-transmission to guarantee data integrity.
 - f. Default device definition to prevent loss of alarms or data and to ensure alarms are reported as quickly as possible in the event an operator device does not respond.
 - g. Automatic synchronization for the real-time clocks in all NCPs and ASCs shall be provided.
- C. Remote Access Communications.
 - 1. Reliable Controls RC-Remote Access with 256-bit encryption.

2.3 NETWORK CONTROL PANELS

- A. Network Control Panels shall be microprocessor-based, multi-tasking, multi-user, real-time digital control processors. Each NCP shall consist of modular hardware with plug-in enclosed processors, communication, controllers, power supplies, and input/output modules. A sufficient number of controllers shall be provided to fully meet the requirements of this specification and the attached point list. A 20% installed spare capacity of each point type (AI, AO, DI, DO) shall be provided at each NCP as part of the base bid. The BCS point capacity shall be capable of being expanded by 200% by the addition of NCPs and ASCs. The BCS shall also support an additional two workstations above those specified herein.
- B. Each NCP shall have sufficient memory to support its own operating system and databases including:
 - 1. DDC and other control Processes

2. Energy Management Applications
 3. Alarm Management
 4. Historical/Trend Data for all points
 5. Maintenance Support Applications
 6. Custom Processes
 7. Operator I/O
 8. Network Communications
 9. Manual Override Monitoring
- C. Each NCP shall support the following types of point inputs and outputs:
1. Digital inputs for status/alarm contacts.
 2. Digital outputs for on/off equipment control.
 3. Analog inputs for temperature, pressure, humidity, flow, and position measurements.
 4. Analog outputs for valve and damper modulation, and capacity control of primary equipment.
 5. Pulse inputs for pulsed contact monitoring.
- D. The BAS shall be modular in nature and shall permit expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators. The system architecture shall support 200% expansion capacity of all types of DDC panels and all point types included in the initial installation.
- E. Network Control Panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of operator I/O devices such as industry standard printers, laptop workstations, PC workstations, modems and portable operator terminals.
- F. Surge and transient protection shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with UL 1449.
- G. In the event of the loss of normal power, there shall be an orderly shutdown of all Network Control Panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the NCP shall automatically resume full operation without manual intervention.

2.4 SYSTEM SOFTWARE FEATURES

- A. General
1. All necessary software to form a complete operating system as described in this specification shall be provided.
 2. The software programs specified in this section shall be provided as an integral part of the NCP or ASC and shall not be dependent upon any higher-level computer for execution.

B. Control Software Description

1. Control Algorithms. The NCP and ASC shall have the ability to perform the following control algorithms:
 - a. Two-Position Control
 - b. Proportional Control
 - c. Proportional plus Integral Control
 - d. Proportional, Integral, plus Derivative Control
 - e. Adaptive Control Loop Tuning
2. Equipment Cycling Protection. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period. Minimum equipment cycle times shall be coordinated with the equipment manufacturer.
3. Equipment Delays. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to electrical loads.
4. Powerfail Motor Restart. Upon the resumption of normal power, the NCP and ASC panels shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

C. Energy Management and Control Applications

1. NCP and ASC panels shall have the ability to perform the following energy management and control routines:
 - a. Scheduled stop/start
 - b. Optimum start/stop.
 - c. Run time totalization.
 - d. Duty cycling.
 - e. Power demand control.
 - f. Night Setback Control.
 - g. Enthalpy or Dry Bulb Economizer.
 - h. Chilled Water Reset.
 - i. Heating/Cooling Interlocks.
 - j. Supply Air Temperature Reset.
 - k. Hot Water Reset.
 - l. Smoke Control.
2. All programs shall be executed automatically without the need for operator intervention and shall be flexible to allow operator customization. Programs shall be applied to building equipment as described in the Execution portion of this specification and in the I/O point sheets.

D. Custom Process Programming Capability. NCP and ASC shall be able to execute custom, job-specific processes defined by the operator to automatically perform calculations and special control routines.

1. Process Inputs and Variables. It shall be possible to use any of the following in a custom process:
 - a. Any system-measured point data or status
 - b. Any calculated data
 - c. Any results from other processes
 - d. User-defined constants
 - e. Arithmetic functions (+, -, *, /, square root, exponential, etc.)

- f. Boolean logic operators (and, or, exclusive or, etc.)
 - g. On-delay/Off-delay/One-shot timers
2. Process Triggers. Custom processes may be triggered based on any combination of the following:
 - a. Time interval
 - b. Time of day
 - c. Date
 - d. Other processes
 - e. Time programming
 - f. Events (e.g., point alarms)
- E. Alarm Management. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each NCP and ASC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the NCP or ASC panel's ability to report alarms be affected by either operator activity at a PC workstation or local I/O device, or communications with other controllers on the network.
1. Point Change Report Description. All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.
 2. Prioritization. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of five priority levels shall be provided.
 3. Report Routing. Alarm reports, messages, and files will be directed to a user-defined list of operator devices or PC disk files used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
 4. Alarm Messages. In addition to the point's descriptor and the time and date, the user shall be able to print, display, or store an 80-character alarm message to more fully describe the alarm condition or direct operator response.
 5. Transaction Logging. Operator commands and system events shall be automatically logged to disk in personal computer industry standard database format. Operator commands initiated from direct-connected workstations, dial-up workstations and portable Operator workstation shall all be logged to this transaction file. This data shall be available at the Operator workstation(s).
- F. Historical Data and Trend Analysis. A variety of historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways:
1. Continuous Point Histories. Network Control Panels shall store point history files for all analog and digital points. Sufficient memory shall be provided within each NCP and ASC to accommodate all historical data collection described in this section.
 2. The point history routine shall continuously and automatically sample the value of all analog inputs at intervals determined by the Operator. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point history files for all points shall include a continuous record of the last ten status changes or commands for each point.
 3. Extended Sample Period Trends. Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting

operator-specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours shall be provided. Each NCP, ASC and portable Operator workstation shall have dedicated memory buffers/hard disk space for trend data.

4. Data Storage and Archiving. Trend data shall be stored at the Network Control Panels and uploaded to hard disk storage when archival is desired.
- G. Runtime Totalization. Network Control Panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.
- H. Analog/Pulse Totalization. Network Control Panels shall automatically sample, calculate, and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
- I. Event Totalization. Network Control Panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

2.5 APPLICATION SPECIFIC CONTROLLERS

- A. HVAC Controllers.
 1. Each Network Control Panel shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).
 2. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, and real-time digital control processor.
 3. Each ASC shall have sufficient memory to support its own operating system and data bases including:
 - a. Control Processes
 - b. Energy Management Applications
 4. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation or portable Operator's workstation connected to any NCP in the network.
 5. Powerfail Protection. All system set points, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.
 6. Configuration Upload and Download. The ASCs shall have the capability of receiving configuration and program loading by all of the following: 1) locally, via a direct connect portable laptop service tool, 2) over the network, from the portable laptop service tool; and 3) from the Operator Workstation(s), via the communication networks.
 7. Continuous Zone Temperature Histories. Application Specific Controllers shall have the capability to automatically and continuously maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored in the ASC or shall be uploaded to the associated NCP or Operator Workstation.

2.6 INTEGRATION WITH THIRD-PARTY MANUFACTURER CONTROLLERS

- A. Interoperability With Equipment Controllers.
 - 1. The BAS shall be capable of interoperating with multiple building systems supplied by different manufacturers. The BAS shall be able to receive, react to, and send information from/to multiple equipment controllers.
 - 2. The system shall allow the custom generation of third-party vendor code on a local level to permit any system to be fully integrated into the BAS network.
 - 3. Input and output points from the third-party controllers shall have real-time interoperability with BAS software features such as Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Dial-Up and Local Area Network Communications, as described previously in the contract documents.
- B. Networking/Communications.
 - 1. The BAS shall support any combination of third-party controllers (if more than one third-party manufacturer is being integrated) on a single network.
 - 2. A minimum of 100 third-party controllers shall be supported on a single network, or as dictated by the third party system architecture.
 - 3. Integration shall be by RS-232 or RS-485 technologies.
- C. Verify and diagnose communication messages and point information between third-party controllers and the BAS.
- D. The BAS shall be able to monitor and control third-party controller point inputs and outputs as defined in the I/O point schedule.

2.7 OPERATOR INTERFACE

- A. Basic Interface Description.
 - 1. Operator workstation interface software shall minimize Operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The system shall utilize any one of the following operating systems:
 - a. Microsoft Windows
 - b. Any system that utilizes a DOS operating system will not be acceptable.
 - 2. At the option of the user, portable and permanent workstations shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.
 - 3. The Operator Interface shall provide simultaneous viewing of several different types of system displays in a windowing environment to speed facility operation and analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air-handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance.

4. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display, and data base manipulation capabilities as is deemed appropriate for each user, based upon an assigned password.
 - a. A minimum of five levels of access shall be supported.
 - b. Operators shall be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, and shall be limited to only those items defined for the access level of the password used to log-on.
 - c. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.
 5. Reports shall be generated automatically or manually and directed to workstation displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - a. A general listing of all points in the network
 - b. List all points currently in alarm
 - c. List of all off-line points
 - d. List all points currently in override status
 - e. List of all disabled points
 - f. List all points currently in alarm lockout
 - g. List all weekly schedules
 - h. List all holiday programming
 - i. List of limits and dead bands
 6. Third-party interface system data, including transactions, alarms totalization files, etc., shall be stored on the portable workstation disk drive in an industry standard database format (e.g., dBase IV, SQL) such that it is compatible with off-the-shelf third-party database and spreadsheet programs.
 7. The BAS shall interface to off-the-shelf personal computer software programs (e.g., Microsoft Word for Windows, Microsoft Excel, Lotus, etc.). This interface shall conform to Dynamic Data Exchange (DDE) protocols and standards. The user shall have the ability to "link" the computer programs directly to live, real-time BCS data values. Systems that offer data exchange using only historical, disk-resident information shall not be acceptable. BAS data value "reads" and "writes" shall both be permissible.
- B. Provide Dynamic Color Graphic Displays as follows:
1. System schematics (for each piece of mechanical equipment including air handling units, chilled water systems, and hot water boiler systems).
 2. Site plans showing all lighting systems controlled by the BAS.
 3. Floor plan of each building floor showing terminal unit and temperature sensor locations. The points displayed on the mechanical system graphic displays shall be based on the I/O point sheets included as part of these Contract Documents.
 - a. System Selection/Penetration. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.
 - b. Dynamic Data Displays. Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention. Values of each analog output shall be indicated on the associated mechanical system graphic display.
 - c. Windowing. The windowing environment of the Operator workstation shall allow the user to simultaneously view several graphics at the same time to analyze total

building operation, or allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

- C. System Configuration and Definition. All temperature and equipment control strategies and energy management routines shall be definable by the Operator. System definition and modification procedures shall not interfere with normal system operation and control.
- D. Portable Operator Workstation:
 - 1. Each NCP and ASC shall be capable of supporting a portable notebook Operator workstation or Portable Operator Terminal (POT) for local command entry, instantaneous and historical data display, and program additions and modifications.
 - 2. The operator functions provided by the Portable Workstation shall include, but not be limited to, the following:
 - a. Start and Stop Points
 - b. Modify Set points
 - c. Modify PID Loop Set points
 - d. Override PID Control
 - e. Change Time/Date
 - f. Add/Modify Start/Stop Weekly Scheduling
 - g. Add/Modify Set point Weekly Scheduling
 - h. Enter Temporary Override Schedules
 - i. Define Holiday Schedules
 - j. View Analog Limits
 - k. Enter/Modify Analog Warning Limits
 - l. Enter/Modify Analog Alarm Limits
 - m. Enter/Modify Analog Differentials
 - n. View Point History Files
 - 3. The Portable Operator Workstation or POT shall provide access to all real or calculated points in the controller to which it is connected (NCP or ASC) or any other controller in the network. This capability shall not be restricted to a set of predefined "global points," but shall provide totally open exchange of data between the Operator workstation or POT and any controller in the network.
 - 4. Operator access at the Portable Workstation or POT shall be identical to the Operator workstations. Any password changes shall automatically be downloaded to all controllers on the network.
 - 5. The Portable Workstation or POT shall provide English language prompting to eliminate the need for the operator to remember command formats or point names. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of Operator error.

2.8 INSTRUMENTATION

- A. Temperature Sensors/Transducers.
 - 1. Provide only one of the following temperature sensor types throughout:
 - a. 1000-ohm, (0.2%) thin film platinum.
 - b. 100-ohm, (0.2 ohm) platinum.
 - c. 1000-ohm, (0.2%) nickel.
 - d. Thermistor (100 or 100000 ohm)
 - 2. All temperature sensors shall be constructed as follows:
 - a. Shielded cable with a single end grounded.
 - b. Waterproof sensor to sheath seal.

- c. Strain minimizing construction.
3. All sensors provided shall meet the following overall end-to-end accuracy requirements whether or not temperature transducers are provided, under all normal building ambient conditions:
 - a. Temperatures less than 100°F shall be reported by the BAS with an accuracy of 0.5°F.
 - b. Temperatures greater than 100°F shall be reported by the BAS with an accuracy of 1.0°F.
 - c. Averaging temperature sensors shall be reported by the BAS with an accuracy of 1.0°F.
 - d. Drift shall not exceed the accuracy requirements over a 5-year period.
 4. Thermowell mount elements shall meet the following additional requirements.
 - a. Stainless steel sheath suitable for the pressure rating of the system.
 - b. Length shall be suitable for application.
 - c. Furnish thermowells and all other accessories required for the temperature sensor. The Mechanical Installer shall supply Wells for installation. Thermowells shall be stainless steel or chrome plated brass construction of size to suit sensor and pipe and shall be rated for the maximum pressure imposed on the various water systems. Verify and certify that the material of construction will not cause any galvanic corrosion.
 - d. Each chilled or hot water supply temperature sensor shall be matched to within 0.2°F over the range of 32°F to 68°F with the associated return water temperature sensor.
 5. Outside air temperature sensor shall meet the following additional requirements:
 - a. Complete with non-corroding outdoor shield designed to minimize the effect of solar heating on the temperature sensor element.
 - b. Water proof seal.
 - c. Threaded fittings for mating to conduit.
 - d. Outside air temperature sensors shall be wired to different NCP. If one sensor or the associated NCP fails the other shall automatically take its place so that sequences of operation that are dependent on this parameter continue to be executed. Sensors shall be located as approved by the Engineer.
 6. Duct mounted temperature sensors shall meet the following additional requirements:
 - a. Copper sheathed construction.
 - b. Length shall be such that the element is between 1/3 and 2/3 the distance across the duct from all sides.
 - c. Ascertain the recommended location of supply air temperature sensors from the air handling unit manufacturer.
 7. Space temperature sensors for non-public spaces shall meet the following additional requirements:
 - a. Wall mounted, white protective enclosure. Provide tamper proof cover where installed in public access areas. Wall mounted enclosures shall be subject to Owner's approval where installed in public areas. There shall be no manufacturer's logos, name or thermometer on casing.
 - b. The Owner shall select location. No sensor shall be mounted until the Owner gives specific location instructions.
 8. Space temperature sensors for all lobbies, public spaces and mullions shall meet the following additional minimum specifications:
 - a. Sensor shall be flush mounted button type located as directed by the Owner.
 - b. The Owner shall approve color of sensor.
 - c. Equal to Reliable Controls SSE3 Sensors.

9. Provide averaging temperature sensors where duct mounted temperature sensors are used to sense mixed air temperature or coil discharge temperature and the cross-sectional area of the duct is 12 square ft. or greater. Averaging temperature sensors shall meet the following requirements:
 - a. Copper sheathed construction. Standard conduit box termination. Lead connections shall be rugged.
 - b. Probe shall have a minimum-bending radius of 12 in.
 - c. Probe shall have a minimum immersion length of 12 ft. or a minimum length of one foot per square foot of duct, whichever is greater.
 - d. Probe shall be single continuous sensing RTD or shall be multiple RTD or thermistor sensors spaced no further apart than 6 in.
 - e. Provide suitable supports at all bends and elsewhere as necessary to ensure that the sensor is held firmly in position and will not incur damage from vibration in the air stream. Support shall be provided, at minimum, every 24 in. in addition to support at bends.
10. If required, RTD temperature transducers to be provided having the following minimum specifications:
 - a. Input circuit to accept resistance detectors as specified above.
 - b. Output signal of 4-20mA into maximum of 500-ohm load. Output signal shall be proportional to the engineering range detailed in the Point Sheets.
 - c. Output short circuit and open circuit protection.
 - d. Input short circuit and open circuit protection.
 - e. Output variation of less than 0.2% of full-scale output for supply voltage variations of 10%.
 - f. Combined non-linearity, repeatability and hysteresis effects not to exceed 0.5% of full-scale output.
 - g. Maximum current to sensor not to exceed manufacturers suggested rating.
 - h. Integral, accessible zero and span adjustments.
 - i. Long term output drift of equal to or less than 0.50% of full-scale output per year.
 - j. Shock and vibration protection as necessary.

B. Humidity Sensors/Transducers

1. Provide outside air, space and duct mounted relative humidity sensors and transducers having the following minimum specifications:
 - a. Range of 0 - 100% RH.
 - b. Combined "end-to-end" accuracy of sensor and transducer, 5% RH between 20% and 80% RH and 6% RH over full range.
 - c. Maximum sensor non-linearity of 5% RH with defined curve. Transducer to provide linearized output.
 - d. Output from transducer shall be 4-20 mA into a maximum of 500-ohm load.
 - e. Output variations of less than 0.2% of full-scale output for supply variations of 10%.
 - f. Maximum output linearity error of 1% if full scale output.
 - g. Integral accessible zero and span adjustments.
 - h. Long term output drift of less than 0.25% of full-scale output per 6 months.
 - i. Dustproof housing.
 - j. Outside air sensor shall be complete with non-corroding outdoor shield designed to minimize the effect of wind or solar heating on the RH sensing element (outdoor only).
 - k. Suitably sized conduit to be provided for any lead wires external to the building or passing through the wall of the building (outdoor only).
 - l. Duct mounted sensor shall have a minimum 8 in. probe.

C. Control Relays

1. Provide interposing control relays having, at minimum, the following specifications:
 - a. Pickup rating time and hold rating as required for individual applications.
 - b. Input operating voltage to be compatible with the BAS digital output equipment.
 - c. Shock and vibration protection as necessary.
 - d. Rated for a minimum of ten (10 million mechanical operations and a minimum of 500,000 electrical operations.
2. The control relays shall be located in the NCP or other local panels as provided by the BAS Installer.
3. The relays shall provide complete isolation between the motor starter, damper actuator or valve actuator, control circuit and the associated BAS digital output.
4. Select control relays such that they meet the following requirements.
 - a. The malfunction of an NCP/ASC component shall cause the motor to fail on or off or maintain previous status as identified in the Sequences of Operation.
 - b. Following the resumption of power after power interruption to a motor, the motor shall not restart until commanded to do so by the BAS in accordance with a predetermined start-up procedure.
 - c. If a motor is detected by the BAS to have failed, i.e. its BAS monitored and commanded status differ, then the BAS shall shut down the motor and restart shall only be possible (when the HOA switch is in the "Auto") by a manually entered restart command at the BAS.
5. Where hand-off-auto (HOA) switches are provided, the BAS digital output shall be wired such that control of the motor is from the BAS in the auto position only.
6. Other interlocks providing safety control, e.g. shutdown on high temperature/vibration detection, etc., shall not be overridden by the BAS control relays or the installation of the control relays.

D. Differential Pressure Transducer - Air Service

1. Provide supply static differential pressure transducers as follows:
 - a. Pressure transducers shall monitor the difference supply duct static pressure and space static pressure. The sensing point in the duct shall be as identified in the sequences of operations. The sensor shall be mounted adjacent to the sensing point in the duct.
 - b. Internal materials of the transducer shall be suitable for the application.
 - c. Output signal of 4-20mA proportional to input pressure, into a 500 ohm load.
 - d. Input range of 0 to 5 in.
 - e. Output variations of less than 0.3% full scale for supply voltage variations of 10% W.C.
 - f. End-to-end accuracy not to exceed 1.0% over entire range.
 - g. Integral, accessible zero and span adjustment.
 - h. Over pressure input protection to a minimum of five times rated input.

E. Differential Pressure Switches - Air Service

1. Provide differential pressure air switches as follows:
 - a. SPDT switch action or two (2) SPST switches rated for 10 amps minimum at 120 Vac.
 - b. Set point trip adjustment over, at minimum, of operating range. Dead band adjustment down to, at maximum, 10% of operating range.
 - c. Operating range of 1.0 in. W. C. to 3.0 in. W. C. for fans with a total static pressure rating of 2.5 in. W. C. or less and 2.0 in. W. C. to 6.0 in. W. C. for fans having a total static pressure rating of greater than 2.5 in. W. C. Operating range of 0 to 1.0 in. W. C. for filter status applications.

- d. Shock and vibration protection as necessary.
 - e. Materials and construction suitable for application.
 - f. Manual reset shall be provided for air differential pressure switches used in high positive and negative pressure output applications. High differential pressure switches shall be provided for all VAV AHU.
 - g. Air differential pressure switches used in filter status applications shall be equipped with an analog gauge. Gauge shall indicate actual differential pressure and differential pressure set point of switch.
2. High differential pressure switches shall be wired in series with other safety devices to the respective motor starter.

F. Thermostats

1. Provide as applicable, low voltage wall mounted thermostats for equipment as identified on the Mechanical Drawings. Install thermostats as located on the Mechanical Drawings.
2. Each thermostat shall be for single stage with a variable set point 65° to 85°F and shall initially be set up to control space temperature as designated in the sequences of operation.
3. Provide a 3°F dead band.
4. The thermostats shall be complete with bases and sub-bases.
5. The thermostats shall be rated for the application, and shall contain sufficient relay contacts to control valves, fans and dampers.
6. Thermostats controlling equipment in hazardous locations shall meet all applicable codes and requirements regarding the respective hazard.

G. Freezestats

1. Provide freezestats with a minimum 20-ft. vapor tension element, which shall serpentine, the inlet face on all air handling unit cooling which receive unconditioned outside air. One or more of these devices shall be provided and wired in series in order to provide one linear foot of coil surface area.
2. The freezestats shall have a manual reset. It shall not be possible for the switch to reset until the duct temperature has increased by at least 10°F above the set point.
3. Hardwire interlock to the associated fan so that fan will shut down when HOT switch is in Hand or Auto position. Provide time delay relays with minimum two (2) minute time delay duration to minimize nuisance freezestats trips.
4. Cut out temperature shall be adjustable in the range of, at minimum, 32°F to 40°F.

H. Current Sensing Relays

1. Provide current sensing relays as follows:
 - a. Solid core current transducer.
 - b. Switching range suitable for the application.
 - c. Self-powered transducer.
 - d. Normally open status contacts.
 - e. Hysteresis amperage of no less than 0.2 amps.

2.9 DAMPER ACTUATOR

A. Damper Actuators.

1. Provide damper actuators for all automatic control dampers, including those furnished as part of a packaged air-handling unit.
2. Electric damper actuators used for two-position service shall be of the spring return type. Modulating dampers shall be motorized in both directions with spring return to the failure (de-energized) position. Unless stated otherwise in these Contract Documents dampers shall fail to the closed position on loss of power. Damper actuators shall have a service life, at minimum, of 60,000 fully closed to fully open to fully closed operations. In addition the modulating damper actuators shall have a service life of, at minimum, 1000 spring operations on loss of power.
3. Actuators shall stroke by the rotating motion of a reversible, overload-protected synchronous motor or shall be direct-coupled rotary type actuators.
4. The actuators shall be protected against overload by an integral magnetic clutch that shall allow the motor to continue running when, for example, the actuator is stalled at the end of its stroke or by a jammed damper. Alternatively, stall protection shall be by non-overloading impedance protected motor.
5. Provide sufficient quantity of additional damper actuators to meet the damper leakage requirements for the installed damper assembly. At minimum the torque provided shall be such as to meet the maximum close-off leakage requirements.
6. Provide mounting brackets suitable for extended shaft mounting or direct damper drive shaft mounting. The actuator housing shall be rugged and non-corrosive.
7. Damper actuator shall be fully accessible for ease of maintenance. Shop drawings shall clearly indicate motor locations on multiple section damper assemblies.
8. The actuators shall stroke two position dampers from fully closed to fully open in less than two (2) minutes. Modulating dampers shall be driven from fully closed to fully open and vice versa in less than two (2) minutes. This time shall not include the initial period following the availability of power, not to exceed 200 seconds, which is required to tension the spring.
9. The control signal to the modulating damper actuators shall be compatible with the BAS analog output subsystem e.g. 4-20 mA, 0 to 10 Vdc, etc.
10. Actuators shall be as manufactured by Belimo, Siemens, Kele, or approved equal.

2.10 SMOKE DETECTORS

- ### A.
- UL listed ionization smoke detectors shall be provided with the new multizone rooftop units. Connect the detectors into the controls circuit to stop the fan in the event of the presence of smoke.

PART 3 - EXECUTION

3.1 GENERAL

- ### A.
- All grounding, wiring, selection of components and installations shall conform to the National Electrical Code with amendments to the date of issue of this specification.

- B. The installation shall conform to each manufacturer's recommended procedures and to all applicable codes, statutes and ordinances and to the Contract Documents. In each and every instance of application, the code, regulation, statute, by-law or specification having the most stringent requirements shall apply.
- C. All installations to be performed by skilled and certified technicians.
- D. All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Provide anti-vibration mounts, if required, for the proper isolation of the equipment.
- E. Install equipment so as to allow for easy maintenance access. Install equipment such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.
- F. Install equipment in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation and with no condensate traps.
- G. All components placed in areas of high humidity or potentially high humidity must be adequately protected.
- H. The existing smoke detectors will remain and be re-used.

3.2 CONDUIT, WIRING, CABLING AND FITTINGS

- A. The installation shall conform to the Division 23 and 26 Contract Documents for this project.
- B. All wires and cables for powering the BAS as provided shall be:
 1. Ninety-eight (98) percent conductivity copper.
 2. A minimum of #12 AWG for branch 120 VAC power circuits.
 3. A minimum of #14 AWG for DO motor control circuits.
 4. A minimum of #18 AWG for sensing, transmitter, DO (except motor control circuits) and AO control circuits. Where manufacturers recommend a heavier conductor, then the BAS Installer shall comply with the manufacturer's recommendation.
 5. A minimum of #20 AWG for communication trunk, shielded and grounded at a single end.
 6. Stranded copper conductors throughout for #18 AWG and smaller diameter wire.
 7. Continuously color coded insulation in accordance with Section 26 05 19 entitled "Wire and Cable".
- C. All cabling shall be plenum rated cable and shall be as specified above with the following additional requirements:
 1. All plenum rated wire and cable shall be a minimum of #18 AWG and shall be shielded.
 2. Cable jacket shall have a minimum thickness of 0.015 in. and shall be bright orange, red, yellow or other bright, distinctive color. Coordinate jacket color with other trades.

3. Plenum wiring and cabling shall be routed through cable rings. Cable rings shall be suitably spaced to properly support plenum cabling and shall be attached to ductwork hangers or structure as applicable.
 4. Plenum cable shall be as manufactured by Belden, Kynar, Dekoron or approved equal.
- D. Smaller gauge wiring shall be acceptable if certified by the equipment manufacturer. If complications arise, however, due to wiring size, replace the wire at no additional cost to the Owner.
 - E. The sizing and provision of conduit and type of wire for the main BAS trunk wiring are the design responsibility of the BAS Installer.
 - F. Obtain and pay for all electrical inspection fees related to the work of this section.
 - G. Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:
 1. All circuits are continuous and free from short circuits and grounds.
 2. All circuits are free from unspecified grounds; that resistance to ground of all circuits is no less than 50 megohms.
 - H. Provide complete testing for all wiring installed or utilized as part of this work. Provide all equipment, tools, and personnel as necessary to conduct these tests.
 - I. Provide complete grounding of all power and signal wiring so as to ensure system integrity of operation.
 - J. NCP/ASC shall not be mounted in-line with vertical conduit but shall be connected off to the side of the vertical conduit by suitably pitched conduit such that any condensed moisture in the vertical conduit cannot enter the NCP/ASC enclosures.
 - K. All analog and digital input points and communication cables shall have shielded wiring. Non-shielded wiring may only be provided upon certification from the manufacturer that non-shielded wiring will not cause degradation of system performance and will not render the system more susceptible to damage. However, if complications arise from the use of non-shielded wiring, replace the wiring at no additional cost to the Owner.
 - L. BAS wiring shall not run in the same conduit as power wiring of any voltage.
 - M. Suitably coated wire may be used in ceiling spaces and in tenant wall partitions without conduit where local codes permit and the cable jacks and insulation have been accepted under the provisions of the National Electrical Code and have been classified by UL, Inc. For use without conduit in air plenums. Elsewhere use Electrical Metallic Tubing (EMT).
 - N. Sleeves shall be provided by the BAS Installer where required and shall meet the requirements detailed in the Division 26 Contract Documents for this project.
 - O. All wiring shall be marked in accordance with the National Electrical Code. Provide the labeling of wire at every termination. Each wire shall be identified which uniquely identifies each wire and which corresponds to the shop Drawings and as-built Drawings provided under this Contract.

3.3 EQUIPMENT, INSTALLATION

- A. Locate temperature sensors, humidity sensors, and thermostats as shown on the mechanical drawings. Prior to installation, coordinate sensor and/or thermostat locations with the Owner and Engineer.
 - 1. Prior to installation, coordinate sensor and/or thermostat locations with Owner's Representative.
- B. Mount local control panels on at convenient locations adjacent to equipment served.
 - 1. Mount all relays, etc., internal to the temperature control panels.
 - 2. Tag each instrument corresponding to symbols used on control diagrams.
- C. Mounting of controllers on air handling units shall not be allowed.

3.4 COMMISSIONING

- A. BAS shall be installed and commissioned by factory-trained technicians skilled in the setting and adjustment of BAS equipment used in this project. This technician is to be experienced in the type of systems associated with this BAS,
- B. Perform a complete and detailed calibration and operational check for each individual point and for each individual function as contained within the BAS. These checks shall ensure that all equipment, software, network elements, modules and circuits as provided under the terms of this contract are functioning as per the Contract Documents. Such checks shall be carried out with the use of point/function log sheets. Point/function sheets are to be prepared by the Contactor and submitted to the Engineer for the approval of content and format. Such calibration and operation checks shall be performed prior to the commencement of final tests on completion for any relevant system part. The point/function logs shall, at minimum, include the following:
 - 1. Identification of each point by BAS point name and expanded descriptor.
 - 2. Indication of BAS value/status, field-tested value/status, and deviation between the BAS and field-tested value/status.
 - 3. Confirmation of system safeties operation.
 - 4. Confirmation of proper failure modes of motors, dampers, valves, etc.
 - 5. Confirmation of proper tuning of PID control loops.
 - 6. Confirmation of proper sequence of operation performance.
 - 7. Manufacturer, model number and accuracy of test instruments used.
 - 8. Date of testing/verification and name of individuals performing the tests.
- C. At time of final observation, demonstrate the sequence of operation for each system to the Owner's Representative and Engineer. Perform system demonstration as directed by Owner's Representative and Engineer.

3.5 TRAINING

- A. Provide a minimum of 40 hours of instructions to Owner's personnel in the operation and maintenance of the control system. Provide training after the system has been installed and commissioned. Training shall be on-site, using the installed BAS as the basis for training. Provide Training Manuals and O&M Manuals for students attending on-site training.

3.6 WARRANTY

- A. At completion of final test of installation and acceptance by Owner, provide any service incidental to proper performance for a period of one year.
- B. Equipment shall be warranted for one year (including defects in workmanship and material) under normal use and service. During warranty period supplier shall also replace or repair, free of charge, any equipment proven to be defective in workmanship or material.
- C. Certain electronic devices not manufactured by the BAS supplier such as computers, etc., shall carry the original manufacturer's warranty. Pass any registration and warranty documents and warranty rights to the Owner.
- D. All software upgrades, enhancements or revisions that are initiated by the BAS manufacturer up to the time of expiration of the warranty period shall be provided at no additional cost to the Owner.

END OF SECTION

SECTION 23 31 13

METAL DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of metal ductwork is indicated on drawings and in schedules, and as may be required to accommodate ductwork connection to new rooftop units.

1.2 QUALITY ASSURANCE

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

1.3 SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Sheet Metal: All interior ducts shall be constructed with G-60 or better galvanized steel (ASTM A 653/A 653M) LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions (i.e. moisture laden exhausts not specified to be stainless steel) shall be G-90 or better galvanized steel LFQ, chem treat.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15° change of direction per section. Unless specifically detailed otherwise, use 45° laterals and 45° elbows for branch takeoff connections. Where 90° branches are indicated, provide conical type tees.
- C. Duct Liner:
 - 1. Fibrous glass, complying with Thermal Insulation Manufacturer's Association (TIMA) AHC-101; of thickness indicated with a minimum installed R-Value equal to 6.0 (1-1/2 in. thick minimum), with black-coated, fire-resistant airstream face, with EPA-registered antimicrobial agent.
 - 2. Flexible Unicellular
 - a. Ductwork Liner: ASTM C534 Type 1, Thickness 1-1/2 : with a minimum R-value equal to R-6.0.
 - 3. Manufacturers:
 - a. Certainteed "Toughgard".
 - b. Knauf Type "EM".
 - c. Johns Mansville "Permacote Linacoustic".
 - d. Owens-Corning "Aeroflex Plus".
 - e. No Substitutions
- D. Duct Liner Adhesive:
 - 1. Comply with ASTM C 916 "Specifications for Adhesives for Duct Thermal Insulation." Application shall conform to Manufacturer's written recommendations for the apparent application.
 - 2. Adhesives shall be non-inflammable after curing.

3. Manufacturers:
 - a. Benjamin-Foster.
 - b. Duro Dyne "FPG".
 - c. Kinco 15-137.
 - d. Miracle PF-91.
 - e. Manufacturer of duct liner used for this project.
- E. Duct Liner Fasteners:
1. Comply with SMACNA "Installation Standards for Rectangular Ducts using Flexible Liner", Articles S2.0 through S2.11.
 2. Comply with lining details as shown in the referenced SMACNA Section, Figures 2-22 and 2-23.
 3. Clinched-pin type fasteners shall be "Grip-Nail", or approved equal.
 4. Projecting pins in Type 3 or Type 4 applications shall be clipped off close enough to the retaining disc to provide proper anchoring and to prevent injury to personnel.
- F. Duct Sealant:
1. Duct sealer shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall seal out water, air, and moisture. Sealer shall be UL listed and conform to ASTM E 84.
 2. Comply with requirements of SMACNA Table 1-2.
 3. Manufacturers:
 - a. Benjamin-Foster
 - b. Ductmate - PROseal.
 - c. Duro Dyne S2.
 - d. Hardcast.
 - e. United Sheet Metal.
- G. Duct Cement:
1. Non-hardening, non-migrating mastic or liquid elastic sealant of type applicable for fabrication/installation detail as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
 2. Comply with requirements of SMACNA Table 1-2.
 3. Manufacturers:
 - a. Benjamin-Foster.
 - b. Duro Dyne S2.
 - c. Hardcast.
 - d. United Sheet Metal.
- H. Ductwork Support Materials:
1. General:
 - a. Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - b. Comply with applicable provisions of SMACNA 2005 Standards, Figures 4-1 through 4-8, and Tables 4-1 through 4-3.

2. Except where space is indicated as "High Humidity" area, interior support materials of not less than 1/4 in. diameter or 3/16 in. thickness may be plain (not galvanized).

2.3 FABRICATION

- A. Shop-fabricate ductwork as required, unless otherwise indicated or required to complete runs. Preassemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match mark sections for reassembly and coordinated installation.
- B. All duct dimensions shown on drawings are net inside clear dimensions.
- C. Shop-fabricate ductwork of gauges and reinforcement complying with SMACNA 2005 Standards as follows:
 1. Rectangular, Steel:
 - a. Tables 1-1 through 1-13.
 - b. Figures 1-2 through 1-18.
 - c. Fittings and Construction, Section II.
 2. Rectangular, aluminum: Pages 1-31 through 1-33.
 3. Round, Oval and Flexible Duct: Section III.
- D. Shop fabricate ductwork of gauges and reinforcement complying with ASHRAE Handbook, HVAC Systems and Equipment Volume, Chapter 16 "Duct Construction".
- E. Longitudinal Seams: Pittsburgh lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Snaplock is not acceptable.
- F. Ductmate or W.D.C.I. proprietary duct connection systems will be acceptable. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.
- G. Formed on flanges (T.D.C./T.D.F./T-25A/T-25B) will only be acceptable when submitted for approval prior to installation of any ductwork. Formed on flanges will be constructed as SMACNA T-25 flanges, whose limits are defined on Page 1.36 of the 2005 SMACNA Manual, First Edition. No other construction pertaining to form on flanges will be acceptable. Formed on flanges shall be acceptable for use on ductwork 42 in. wide or less, with 2 in. positive pressure static or less, and must include the use of corners, bolts and cleat.
- H. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center line radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30° for contracting tapers and 20° for expanding tapers.
- I. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division 23 Section "Ductwork Accessories" for accessory requirements.
- J. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners. Comply with previous paragraph 2.2.

- K. Pressure Classifications:
1. Static pressure ratings for ductwork systems shall be as noted on the drawings, and/or shall conform to requirements of 2005 SMACNA Standards, Table 1-1.
 2. In no case shall the pressure rating of the duct be less than that indicated in Table 1-1 for the apparent duct velocity.
 3. Gauges of metal and reinforcing methods shall conform to SMACNA requirements as follows:
 - a. Rectangular Steel: Table 1-3 through 1-13.
 - b. Rectangular Aluminum: Tables 1-14 through 1-16.
 - c. Round, or Flat Oval, Steel: Table 3-2.
 - d. Round Aluminum: Table 3-3.

2.4 FACTORY-FABRICATED DUCTWORK

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

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION OF METAL DUCTWORK

- A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight (5% leakage for systems rated 3 in. and under; 1% for systems rated over 3 in.) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8 in. misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type that will hold ducts true to shape and to prevent buckling. Support vertical ducts at every floor. Seal all longitudinal and transverse duct joints and seams with non-hardening duct mastic.

- B. Field Fabrication: Complete fabrication of work at project as necessary to match shop fabricated work and accommodates installation requirements.
- C. Electrical Equipment Spaces: Do not route ductwork through Electric Rooms, transformer vaults, and other electrical equipment spaces and enclosures.
- D. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- E. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.

3.3 INSTALLATION OF DUCT LINER

- A. General: Install duct liner in accordance with SMACNA HVAC Duct Construction Standards, pages 2-25 thru 2-29.

3.4 FIELD QUALITY CONTROL

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

3.5 EQUIPMENT CONNECTIONS

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

3.6 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

- B. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.
- C. Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until time connections are to be completed.
- D. Balancing: Refer to Division 23 Section "TESTING, ADJUSTING AND BALANCING" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION

SECTION 23 74 13

MULTIZONE ROOFTOP HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged rooftop heating and cooling units.
- B. Related Sections:
 - 1. Section 23 05 12 - MECHANICAL AND ELECTRICAL COORDINATION.
 - 2. Section 22 10 00 - PLUMBING PIPING.
 - 3. Section 23 31 13 - METAL DUCTWORK.
 - 4. Section 23 09 33 - BUILDING AUTOMATION SYSTEM for automatic controls, not factory-installed, required in conjunction with rooftop units.

1.2 SUBMITTALS

- A. General: Do not use submittals as a proposal for equipment that has not been pre-approved during the bid process.
 - 1. Do not base bids on unapproved items!
- B. Product Data: Submit manufacturer's technical product data, indicating full compliance with scheduled capacities and characteristics, including specific capacities at the scheduled entering air conditions, dimensions, weights, operating clearances and specific references to all specialties and accessories as scheduled or specified, including installation and start-up instructions.
 - 1. Data that does not apply to this specific project shall be marked out, or suitably deleted.
 - 2. Units shall be specifically identified, using the same nomenclature as shown on the plans.
- C. Shop Drawings: Submit Shop Drawings detailing the following:
 - 1. Electrical requirements for power supply.
 - 2. Ladder-type wiring diagrams for interlock and control wiring. Wiring diagrams shall clearly delineate field and factory wiring requirements, as well as the incorporation of special features that only apply to this specific project.
 - 3. Details of the mounting, securing and flashing of the roof curb to the roof structure, including coordinating requirements with the roof membrane system.
- D. Operation and Maintenance Data: Include maintenance data and parts lists for each rooftop unit, including "trouble-shooting" and maintenance guide, servicing guide and preventative maintenance schedule and procedures in the Maintenance Manual required in accordance with requirements of Division 01.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of rooftop heating and cooling units, of the types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Gas-Fired Furnace Sections: Constructed in accordance with applicable AGA Standards, and bearing the AGA Seal.
 - 2. Testing and Rating Standards: Comply with applicable provisions of the following standards in effect as of the date of the Contract documents:
 - a. ARI 210 "Standard for Unitary Air Conditioning Equipment".
 - b. ARI 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment."
 - c. ARI 270 "Standard for Sound Rating of Outdoor Unitary Equipment."
 - d. Equipment shall bear the appropriate Certified Rating Seal.
 - e. Refrigeration system construction shall comply with ASHRAE Standard 15 "Safety Code for Mechanical Refrigeration," latest edition.
 - f. Energy Efficiency Ratio (EER) of rooftop units shall be not less than that indicated in ASHRAE Standard 90.1. "Energy Conservation in New Building Design", latest edition.
 - g. Unit shall be certified in accordance with ANSI Z21.47b / CSA 2.366 and ANSI ZB3.B / CSA 2.6, Safety Standard Gas-fired Furnaces.
 - 3. Rooftop units shall be U/L-listed, and the unit shall bear the U/L label.
 - 4. Rooftop units shall be designed, manufactured and tested in accordance with UL requirements.
- C. Units shall be started and run tested before shipment.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Handle rooftop units and components carefully to prevent damage. Replace damaged rooftop units or components with new.
- B. Store rooftop units and components in a clean, dry place, off the ground, and protect from weather, water, and physical damage.
- C. Rig rooftop units to comply with the manufacturer's rigging and installation instructions for unloading such equipment, and moving them to the final location.

1.5 SCHEDULING AND SEQUENCING

- A. Coordinate installation of roof-mounting curb with roof structure.
- B. Coordinate roof opening locations and mechanical, electrical, gas and drain locations.

1.6 WARRANTY

- A. Warranty on Entire Unit: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, any components which show inadequate and defective materials and/or workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting and maintaining units have been properly followed during the warranty period. Replacement shall include component replacement and shall include labor for removal and re-installation.
1. Warranty Period: 1 year from date of substantial completion. Note that the Owner will accept units on a unit-by-unit basis, so that each unit will have it's own substantial completion date.
 2. Warranty Card shall plainly state the name of the project, the started and ending dates fo the warranty period, and the serial numbers of the included equipment.

1.7 SPECIAL WARRANTY

- A. Warranty on Compressor and Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and heat exchanger which show inadequate and defective materials and/or workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting and maintaining units have been properly followed during the warranty period. Replacement is limited to component replacement only, and does not include labor for removal and re-installation.
1. Warranty Period: 5 years from date of substantial completion for the Compressor.
 2. Warranty Period: 15 years from date of substantial completion for the Heat Exchanger.
 3. Warranty Card shall plainly state the name of the project, the starting and ending dates of the warranty period, and the serial numbers of the included equipment.

1.8 FIRST YEAR MAINTENANCE MATERIALS

- A. Maintenance Materials: Furnish to Owner, with receipt, the following maintenance materials:
1. One extra set of matched fan belts for each belt-driven fan for each rooftop unit.
 2. One extra set of filters for each rooftop unit.

PART 2 - PRODUCTS

2.1 MULTIZONE ROOFTOP UNITS

- A. Manufacturers: Subject to compliance with requirements, provide rooftop units of one of the following:
1. Custom Air Products & Services, Inc.
 2. Temtrol.
 3. Custom Mechanical Equipment.

B. General Description

1. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, multi-zone dampers, air-cooled condenser coils, condenser fans, indirect fired gas heaters, return/exhaust fans, economizer dampers, and unit controls.
2. Unit shall be designed to match existing roof curb and existing supply and return duct connections.
3. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
4. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
5. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
6. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
7. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

C. All rooftop units shall be fabricated so that they fit on existing roof curbs that will be re-used.

D. Construction

1. The unit shall employ aluminum material wherever possible (pans, panels, racks, safing, etc.) to reduce over-all weight and minimize facility maintenance requirements while enhancing corrosion resistance. The unit will be built/shipped in one-piece.
2. The air handling unit panel casing system shall be built up from the unit base, using a structural aluminum extrusion frame. The framing system assembly shall be accomplished using structural members and mechanical fasteners. Vertical and horizontal wall, roof, and floor supports shall be incorporated and spaced to enable the finished enclosure to withstand the system design static pressures as listed on the equipment schedule. Structural frame supports shall be extruded from 6063 alloy T5 temper aluminum as a minimum.
3. The unit panel sheet shall be .063 thick textured (leather-grain) aluminum. A thermal break consisting of a double-back tape or gasket shall be installed between all of the housing sheeting and the structural aluminum frames. Mechanical fasteners such as stainless-steel screws or rivets shall also be employed to secure the housing sheeting to the structural aluminum members. Double wall inner panel to be fabricated from .050 aluminum. The interior flooring of unit shall be 1/8" aluminum treadplate.
4. The housing panels shall be installed to seat against the unit pressure where possible, that is, against the flange of the structure framing system extrusions.
5. Panels shall be joined together with a neat and clean appearance. Any safing, internal partitions, or other tie-ins to the casing shall be made using internal support angle extrusions or panels that are a part of the casing. Such members may be bolted, screwed, or riveted to or through the support structure.
6. Each unit section shall have an access door, removable plug panel, or special service feature for motor removal as outlined. Through properly designed access, ease of

maintenance, and removability of components, unit serviceability shall be assured. Access doors and removable panels shall be of the same construction (double-wall) as the unit housing panels above. They shall be guaranteed tight closing by means of a continuous separate gasket seal around the entire door periphery, to assure a true perpendicular, tight, non-shearing compression fit.

7. Each section shall be factory insulated. Insulation shall have full coverage waterproof adhesive to firmly secure the material to the unit casing. Insulation shall meet the erosion requirements of UL 181.
 - a. 2-in., Thermax foam board – Panels shall have an R – value of 13.0.

E. Electrical

1. Unit shall be provided with factory installed and factory wired, fused disconnect switch.
2. Unit shall be provided with a factory installed and factory wired 115V, 12 amp GFI outlet in the unit control panel.
3. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

F. Supply fans

1. Motorized impeller with single-sided intake, rear-curved motor impeller, energy-optimized for operation without spiral housing through special blade design with rotating, vaneless diffuser for high efficiency and with favorable acoustic behavior. Centrifugal impeller made of high-strength composite material, with external rotor motor statically and dynamically balanced. Galvanized inlet nozzle with volume flow rate measuring equipment. Over temperature protection of the device electronics through active temperature management.
2. Fans shall have direct drive, variable speed ECM (motors).

G. Exhaust Fans

1. Motorized impeller with single-sided intake, rear-curved motor impeller, energy-optimized for operation without spiral housing through special blade design with rotating, vaneless diffuser for high efficiency and with favorable acoustic behavior. Centrifugal impeller made of high-strength composite material, with external rotor motor statically and dynamically balanced. Galvanized inlet nozzle with volume flow rate measuring equipment. Over temperature protection of the device electronics through active temperature management.
2. Fans shall have direct drive, variable speed ECM (motors).

H. Cooling Coils

1. General Fabrication:
 - a. All water and refrigerant coils shall have 1/2" or 5/8" OD seamless copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.016 inches.
 - b. Aluminum-finned coils shall be supplied with die formed casing and tube sheets of 304 stainless steel on evaporative coils and mill galvanized steel on condensing coils. Minimum fin thickness 0.006 inches.
2. Refrigerant Coils:
 - a. Headers shall be seamless copper tubes with brazed joints.

- b. Coils shall be provided with a brass liquid distributor with solder type connection. Distributors shall have removable brass venture (nozzles). Distributors to coil capillary feeder tubes shall be seamless copper.
- c. Coils for full face-active or face-split operation shall have intertwined circuits for equal loading on each circuit. Suction and liquid connections shall be on the same end.

I. Refrigeration System

- 1. Unit shall be factory charged with R-410A refrigerant.
- 2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
- 3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
- 4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
- 5. Unit shall have multiple refrigeration circuits. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
- 6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
- 7. Unit shall have four independent circuits. Each compressor circuit shall have a low-pressure control, filter dryer, fan cycling control, thermostatic expansion valves with equalizer line connection and sight glasses.

J. Condensers

- 1. Air-Cooled Condenser
 - a. Outdoor condenser fans shall be propeller type, direct drive, with permanently lubricated bearings. Motors shall be high efficiency. Condenser fans shall discharge air vertically upward away from the unit.
 - b. Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from seamless copper tubes with brazed joints.
 - c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
 - d. Condenser fans shall be high efficiency electronically commutated motor driven with factory installed head pressure control module. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 0°F with adjustable compressor lockout.
 - e. Coils shall be hydrogen or helium leak tested.
 - f. Condensing coils shall be protected by hailguards.

K. Gas Heating

- 1. Unit shall include a natural gas furnace with modulating capacity control.
- 2. Stainless steel heat exchanger furnace shall carry a 15 year non-prorated warranty, from the date of original equipment shipment from the factory.

3. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
4. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
5. Unit shall include a single gas connection and have gas supply piping entrances in the outside cabinet wall for across the roof gas piping.
6. Modulating Natural Gas Furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet.

L. Filters

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil.
2. Unit shall include 1 inch aluminum mesh pre filters upstream of the outside air opening.
3. Unit shall include a clogged filter switch which will notify the Control System.
4. Unit shall include a Magnehelic gauge mounted in the controls compartment.

M. Dampers

1. Control Dampers –Blades shall be mechanically fastened to hex axle rod rotating in self-lubricating synthetic bearings. To eliminate blade warping, dampers shall be sectionalized to limit blade length to 48 inches maximum.
2. Multi – Zone Dampers – Damper frame and blades shall be constructed from extruded aluminum with neoprene blade seals. Linkage shall have external connections. Number of zones shall vary by size of sections.

N. UV-C Lights

1. Install UV-C lights within cooling coil section. The UV-C light system shall provide minimum 20 Watts per square foot of coil coverage area and shall be complete with toggle switch, UV-C hour meter, warning signage, and 1 year lamp warranty. The W-C lights shall be controlled by the BAS so that they can be enabled/disabled via BAS control.

- O. Provide stainless steel, galvanized, or plastic insulated drain pan, located under cooling coil section, extensive enough to catch condensate leaving the coil at highest catalogued face velocity. Provide at least one drain connection at low point in drain pan. Drain connections shall be located so as to provide and ensure positive condensate drainage – no standing water.

P. Controls

1. All controls shall be furnished and installed by the Building Automation System (BAS) Installer. Refer to SECTION 23 09 23. Closely coordinate with installer to ensure that all necessary control functions are provided.
- Q. Safety controls: Manual reset type for:
1. Low pressure cutout
 2. High pressure cutout
 3. Compressor motor overload protection
- R. Heat exchanger: Manufacturer's standard construction for gas-fired aluminized steel heat exchanger and burners.
1. Controls:
 - a. Intermittent pilot ignition.
 - b. Electronic spark ignition system.
 - c. High limit cutout.
 - d. Forced draft proving switch.
- S. Smoke Detector: Provide unit mounted UL Ionization smoke detector in return air section. Connect the detectors into the control circuit to stop the fan in the event of the presence of smoke. Connection to Fire Alarm System by Division 26

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Install and secure rooftop units on curbs and coordinate any roof penetrations and/or flashing.

3.3 DEMONSTRATION

- A. Start-Up Services: Provide the services of a factory- authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Operating and Maintenance Training:
 1. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall consist of a minimum of 8 hours, not necessarily consecutive, and shall include start-up and

shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division One.

2. Schedule training with Owner; provide at least 7-day prior notice to the Engineer.
3. Provide a written report of training periods to Owner and Engineer.

3.4 PIPING CONNECTIONS

- A. Refer to Sections 22 10 00 of these specifications for natural gas and condensate drain piping.

END OF SECTION

SECTION 26 05 10

GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 DRAWINGS AND SPECIFICATIONS

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

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

1.3 CODES AND STANDARDS

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

PART 2 - PRODUCTS

2.1 SHOP DRAWINGS AND SUBMITTALS

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

- H. Contractor agrees that Shop Drawing submittals reviewed by the Engineer are not change orders; that the purpose of Shop Drawing submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that 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.

2.2 STANDARDS FOR MATERIALS

- A. It is the intention of these specifications to indicate a standard of quality for all materials incorporated in this work. Manufacturer's names and catalog numbers are used to designate the item of equipment or material as a means of establishing grade and quality. Where several manufacturers are named, only the named manufacturer's products will be considered and the Contractor's bid shall be based on their product.
- B. Where the phrase 'or approved equivalent' or 'or equivalent' or 'equivalent to' or 'accepted substitute' is used in these specifications, the names or name mentioned are to be used as a basis of quality. Other manufacturers will be considered if the quality of the proposed material is equivalent to that of materials named, in the opinion of the Engineer. Such unnamed manufacturers' products will, however, be considered as substitutions and shall not be used as a basis for bidding.
- C. Basis of quality shall include material, workmanship, weight, finishes, and gauges of material, appearances, capacity and performance. Manufacturer's representation as to availability of equipment, replacement parts and service personnel in the area will be a factor in consideration of submittals.
- D. All materials shall be fully warranted.
- E. Furnish standard products and manufacturers regularly engaged in production of such equipment.
- F. Furnish manufacturer's latest standard design.
- G. All equipment shall conform with applicable IEEE, UL, ANSI and/or NEMA Standards.
- H. Obtain manufacturer's recommendations and instructions for all installed equipment including installation instructions, preparation cleaning, tests and preservice checks, and then ensure all have been performed prior to completion of work.

2.3 SUBSTITUTIONS

- A. The Engineer prior to installation shall approve substitutions of equipment. Substitution of equipment shall be in accordance with Division 01 of the specifications.
- B. Requests for substitutions of equipment, materials and apparatus listed in Division 26 Sections must be submitted in writing as a question during the prescribed timeframe for submitting questions. Refer to the instructions for bidders for timeframe. Such requests must be accompanied by complete data to permit proper evaluation.
- C. When alternate or substitute materials and equipment are used, the Contractor shall be responsible for space requirements, configurations, performance, changes in bases,

supports, structural members and openings in structure, and other apparatus and trades that may be affected by their use.

- D. Contractor shall bear all additional costs resulting from the use of substituted materials. Such changes shall be at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 COORDINATION

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

3.2 PERMITS AND FEES

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

3.3 QUALITY ASSURANCE

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

3.4 PRODUCT DELIVERY, STORAGE AND HANDLING

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

3.5 CLEANING UP

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

3.6 CUTTING AND PATCHING

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

3.7 FLASHINGS, SLEEVES, INSERTS

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

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

3.8 PAINTING

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

3.9 IDENTIFICATION OF ELECTRICAL EQUIPMENT

- A. Identify electrical equipment in accordance with the NEC, local authorities and in accordance with the requirements of the Contract Documents.
- B. Use laminated three-ply, engraved plastic nameplates with black surface and white interior core, at least 1/16 in. thick. Engraved lettering shall be condensed gothic at least 1/4 in. high and properly spaced for legible and easy reading. Attach plates to equipment with chromium-plated screws. Adhesive attachment is not acceptable. Identify the following items with engraved nameplates, located as follows:
 - 1. Each switch/fuse unit or circuit breaker in each main panel and each distribution panel - adjacent to switch/fuse unit or circuit breaker.
 - 2. Spares shall be labeled 'Spare'.
 - 3. Each branch circuit panel - on panel trim cover immediately above panel door.
 - 4. Each safety switch - on outside of cover. Include the power source on safety switches.
 - 5. Each motor starter - on outside of cover.
- C. Refer to other sections of the specifications for conductor color-coding requirements.

3.10 ACCESS DOORS

- A. Wherever access is required in walls, ceilings, or soffits to concealed junction boxes, pull boxes or other electrical equipment installed under this division, provide and install access doors as indicated herein.
- B. Furnish and install hinged access door and frame with flush latch handle as follows:
 - 1. Plaster surfaces - Milcor Style K, or accepted substitute.

2. Ceramic tile or drywall surface - Milcor Style M (with 'B' label where required), or accepted substitute.
3. Install panels in locations approved by the Engineer and paint as directed.

3.11 RECORD DOCUMENTS

- A. Job set: Promptly following receipt of the Owner's Notice to Proceed, secure from the Engineer at no charge to the Contractor, one complete set of all Documents comprising the Contract.
- B. Final Record Documents: At a time nearing the completion of the work, secure from the Engineer at no charge to the Contractor one complete set of sepia transparencies of all Drawings in the Contract.
- C. Maintenance of Job Set: Immediately upon receipt of the job set described in paragraph above, identify each of the Documents with the title, "RECORD DOCUMENTS - JOB SET".
- D. Preservation:
 1. Considering the Contract completion time, the probable number of occasions upon which the job set must be taken out for the new entries and for examination, and the conditions under which these activities will be performed, devise a suitable method for protecting the job set to the approval of the Engineer.
 2. Do not use the job set for any purpose except entry of new data and for review by the Engineer, from start of transfer of data to final Project Record Documents.
 3. Maintain the job set at the site of Work where the Engineer designates that site.
- E. Making Entries on Drawings:
 1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required.
 2. Date all entries.
 3. Call attention to the entry by a 'cloud' drawn around the area or areas affected.
 4. In the event of overlapping changes, use different colors for the overlapping changes.
 5. All equipment shall be clearly indicated in its installed location. Exposed items or those easily accessible, as above lay-in ceilings, may be located to scale. Concealed items not readily accessible, such as underground piping, shall be located by dimension.
- F. Transfer of Data to Final Project Documents:
 1. Approval of recorded data prior to transfer:
 - a. Following receipt of the transparencies described above, and prior to beginning transfer of recorded data thereto, secure the Engineer's approval of all recorded data.
 - b. Make required revisions.
 2. Transfer of Data to Drawings:
 - a. Carefully transfer change data shown on the job set of Record Drawings to the corresponding transparencies, coordinating the changes as required.

- b. Clearly indicate at each affected detail and other drawing a full description of changes made during construction, and the actual location of items described above.
- c. Call attention to each entry by drawing a 'cloud' around the area or areas affected.
- d. Make changes neatly, consistently, and with the proper media to assure longevity and clear reproduction.

G. Review and Submittal:

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

3.12 OPERATIONS AND MAINTENANCE DATA

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

3.13 INSTRUCTION OF OWNER'S PERSONNEL

- A. Provide the services of competent engineers or technicians acceptable to the Engineer to instruct representatives of the Owner in the complete and detailed operation of each item of equipment, and each system. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results. Upon completion of these instructions, the Contractor shall obtain a Letter of Release, acknowledged by the Owner or his Authorized Representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.
- B. Be responsible for proper maintenance of equipment and systems until the instructions have been given to the Owner's personnel and the letter of release acknowledged.
- C. In providing the instructions to the Owner's personnel, follow the written operating and maintenance manuals in all instances, and familiarize the Owner's personnel with such manuals. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturers' operation and maintenance manuals, parts lists (with sources identified), and other data as appropriate for each system, and as required elsewhere in the Specifications to be furnished to the Owner prior to final acceptance of the project.

3.14 LOCAL PARTS AND SERVICE

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

3.15 INSTALLATION INSPECTIONS AND CERTIFICATIONS

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

3.16 OPERATION PRIOR TO ACCEPTANCE

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

3.17 ACCEPTANCE OF THE WORK

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

3.18 WARRANTY

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

3.19 FINALLY

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

END OF SECTION

SECTION 26 05 11

WORK IN EXISTING BUILDING

PART 1 - GENERAL

1.1 DESCRIPTION

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

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

3.2 DISRUPTION OF EXISTING FUNCTIONS

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

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

3.3 SALVAGE, DEMOLITION AND RELOCATION

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

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

3.4 EXISTING RACEWAYS

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

3.5 NEW RACEWAYS

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

3.6 EXISTING CEILINGS

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

3.7 EXISTING PANELBOARDS

- A. Service existing panelboards to be reused as follows:
 - 1. Clean interiors and exteriors.
 - 2. Touch-up damaged finishes with manufacturer's matching touch-up paint.
 - 3. Inspect for component damage and repair or replace as necessary.
 - 4. Tighten conduit and wire terminations.
 - 5. Rebalance loads as specified in other sections of the specifications to provide for evenly balanced phases.
 - 6. Provide new typewritten circuit directories.
 - 7. Provide new panelboard identification labels if panelboard designation changes or if no labels exist.

3.8 EXISTING WIRING

- A. Inspect existing wiring to be reused for damage. Repair or replace damaged wiring.
- B. Assure integrity of existing wiring insulation as follows:
 - 1. Megger wiring phase-to-phase, phase to neutral, phase to ground, and neutral to ground.
 - 2. Record megger results. Provide typewritten record of results to the Architect for review.
 - 3. Repair defective insulation to a dielectric value equivalent to that of wire of the same type.
 - 4. Existing wiring may be replaced with new wiring if, in the Contractor's opinion, costs to the Owner would be lower.
- C. Secure and label existing wiring that is to be disturbed.
- D. Tighten existing wiring terminations and connections.

3.9 EXISTING FOUNDATIONS AND FLOORS

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

END OF SECTION

SECTION 26 05 12

MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 WORK INCLUDED

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

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

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

	ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
27.	Alarm bells or horns for fire protection (sprinkler) system	21	21	28
28.	Generator (underground) fuel tank	22	22	--
29.	Generator fuel level indicator	22	22	26
30.	Generator fuel piping from tank to generator	22	22	--
31.	Underground fuel tank leak detection and monitoring system	22	22	22

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

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

C. PRECEDENCE

1. In general, piping systems that require a stated grade for proper operation shall have precedence over other systems.
2. Precedence for pipe, conduit and duct systems shall be as follows.
 - a. Building lines
 - b. Structural members
 - c. Soil and drain piping
 - d. Vent piping

- e. Steam piping
- f. Condensate piping
- g. Refrigerant piping
- h. Electrical bus duct
- i. Supply ductwork
- j. Return ductwork
- k. Exhaust ductwork
- l. Chilled water and heating water piping
- m. Automatic Fire Protection Sprinkler Piping
- n. Natural gas piping
- o. Domestic hot and cold water piping
- p. Electrical conduit

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

D. FINAL INSPECTION AND REPORT

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

END OF SECTION

SECTION 26 05 19

WIRES AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

2. Where installed above existing inaccessible ceilings to points 12 inches maximum beyond the edges of the existing ceiling.
 3. Where installed in accessible ceiling spaces in lengths not exceeding six feet if allowed by local building codes.
 4. Branch circuit wiring. However, MC cable may not be used for homeruns.
- H. Armored cable type MC: Galvanized, interlocking steel sheath. 90°C, 600V copper conductors with THHN/THWN insulation. Insulated copper conductor ground wire.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

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

3.2 PHASING

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

120/208 Volt
 Phase A - Black
 Phase B - Red
 Phase C - Blue
 Neutral - White
 Ground - Green

277/480 Volt
 Phase A - Brown
 Phase B - Orange
 Phase C - Yellow
 Neutral - Gray

- B. Provide green or bare grounding conductor identification for grounding conductors. Identification of all ungrounded conductors at junction boxes, wireways, and/or terminations may be by means of colored tape or painting when color-coded conductors as specified above are not available.
- C. Phasing of the complete electrical installation shall be connected and maintained the same throughout the power distribution system. Where the project is an addition or modification to an existing facility, the electrical distribution system phasing shall be made the same as the existing.
- D. Switchgear, safety switches, motor starters, plug-in type bus duct, lighting and power panels and power receptacles shall have all the same phase arrangements throughout the facility.

3.3 INSTALLATION

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

- K. Test all circuits for grounds. Prove and test energy available at the load side of disconnect switches and at the final point of connection to driven equipment. Make all necessary and reasonable tests as required by the Architect to prove the integrity of work and leave the complete electrical installation ready for operation.

END OF SECTION

SECTION 26 05 20

WIRE CONNECTION AND DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Make all electrical power and control connections to equipment furnished under other divisions of the specifications and furnish wiring, conduit, outlet boxes, disconnect switches, etc., as required for same. Check General Construction, Controls, Plumbing, Heating, and Air Conditioning, etc. plans and specifications to determine the amount of such wiring required and include cost of same in bid. Verify locations, horsepower, voltages, etc., of all equipment as the job progresses. If a conflict arises in wiring, ask the Engineer immediately for clarification.
- B. Provide branch circuits and connections to all motors furnished to this project. Provide all disconnect switches as shown and where required by national or local codes. In general, all wiring shall be in conduit, with a short section of flexible conduit at each motor. Securely attach conduit to flexible conduit. When the motor is an integral part of equipment, isolate

with a short section of flexible metal conduit to prevent vibration and/or noise amplification to the building structure. If the motor is adjustable, an additional length of flexible metal conduit shall be installed at the motor. Connect a ground wire from the conduit termination to the motor frame on the inside of the flexible conduit. Use approved grounding lugs or clamps on the conduit connection.

- C. Branch circuits and connections to all electrically operated equipment are included in this contract, whether or not specifically mentioned. Check, on the job, for further details on Plumbing, Heating, and Air Conditioning equipment as project progresses. Ground equipment in an approved manner.
- D. Major equipment furnished under the mechanical and other sections of the specifications may require different rough-in requirements than indicated on the plans due to the 'or equivalent' equipment clause. Secure detailed drawings from the trade furnishing the equipment to determine actual rough-in locations, conduit and conductor requirements.
- E. Before connecting equipment, check the nameplate data against the information shown on the Drawings. Call any discrepancies to the attention of the Architect.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

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

PART 2 - EXECUTION

2.1 INSTALLATION

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

2.2 COORDINATION

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

END OF SECTION

SECTION 26 05 27

SEALING OF PENETRATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

2.2 ROOF PENETRATION SYSTEMS

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION

SECTION 26 05 29

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

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

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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

2.2 MATERIALS

- A. Continuous slotted channel: 12 gauge steel with electro-galvanizing and gold zinc dichromate barrier bases and dimensions as required for application.
- B. Hanger rods: Continuous thread, electro-galvanized, steel, with gold zinc dichromate barrier, sizes as required for loads imposed.
- C. Hex head cap screws and nuts: No. H-113 and No. 114, respectively.
- D. One-hole pipe straps: Series HS-100, galvanized steel.
- E. Single bolt channel pipe straps: Steel, with machine screw and nut, Series C-105 and Series C-106.
- F. Lay-in pipe hanger: Series C-149.
- G. Conduit and pipe hanger: Series 6H.
- H. Beam clamps: Series 500, RC, EC and PC as applicable.
- I. Concrete inserts, spot: Series D-256 or D-255.
- J. Concrete inserts, channel: Series D-980 or Series D-986.

- K. Riser clamps: Series C-210.
- L. Cable supports: O.Z./Gedney Type S.

PART 3 - EXECUTION

3.1 INSTALLATION

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

- O. Provide steel angle and channel supports to the floor and structure for panelboards, cabinets, pull and junction boxes. Provide independent support from entering conduits and raceways.
- P. Provide supports as specified for conduits and raceways for outlet boxes and pull boxes 100 cubic in. and smaller.
- Q. Paint all cuts, breaks, welds and other points where the rust inhibiting coating of supports is damaged.
- R. Provide supports sized for the ultimate loads to be imposed.
- S. Anchor supporting devices with:
 - 1. Wood screws on wood.
 - 2. Toggle bolts on hollow masonry.
 - 3. Bolts and expansion anchors in concrete or brick.
 - 4. Machine screws, threaded rods and clamps on steel.
- T. Provide supports with hot-dipped galvanized finish in outdoor and wet locations.
- U. Pipe and conduit supports:
 - 1. Single run pipe and conduits, 2-1/2 in. O.D. and less, shall have Type SS-8R/SS-8C as manufactured by Portable Pipe Hangers, Inc., or approved equivalent, spaced at maximum eight ft. on center and installed on roof pads if required by the roofing manufacturer.
 - 2. Multiple run pipe and conduits larger than 2-1/2 in. O.D. shall have Type PS, PSE, PP-10 with Roller, or PP-10 with Bar, as manufactured by Portable Pipe Hangers, Inc., or approved equivalent, spaced at maximum eight ft. on center and installed on roof pads if required by the roofing manufacturer. All conduits shall be held in place with clips on bars.

END OF SECTION

SECTION 26 05 32

PULL AND JUNCTION BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

END OF SECTION

SECTION 26 05 33

CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

1. Rigid nonmetallic conduit systems - PVC coated rigid metal conduit.
 2. Other conduit systems - same material as the conduit with which they are installed.
- H. Bushings:
1. 1-1/4 in. and smaller - high-impact thermosetting phenolic insulation, 150°C, O-Z/Gedney Type A.
 2. 1-1/2 in. and larger - hot-dipped galvanized with thermosetting phenolic insulation, 150°C, O-Z/Gedney Type B.
- I. Locknuts:
1. 1-1/4 in. and smaller - zinc-plated heavy stock steel, O-Z/Gedney.
 2. 1-1/2 in. and larger - cadmium-plated malleable iron, O-Z/Gedney.
- J. Hubs: Cadmium-plated malleable iron, tapered threads, neoprene 'O' ring, insulated throat, O-Z/Gedney.
- K. EMT Connectors: Compression type, zinc-plated steel body, cadmium-plated malleable iron nut, insulated throat, O-Z/Gedney.
- L. EMT Couplings: Compression type, zinc-plated steel body, O-Z/Gedney.
- M. Liquid tight Conduit Connectors: Cadmium-plated malleable iron body and nut, cadmium plated steel ferrule, insulated throat, integrally-cast external ground lug, O-Z/Gedney Type 4QL.
- N. Through-Wall and Floor Seals: Malleable iron body, oversize sleeves, sealing rings, pressure clamps and hex-head cap screws, O-Z/Gedney Type FSK.
- O. End Bells: Hot-dipped galvanized, threaded, malleable iron, O-Z/Gedney Type TNS.
- P. Expansion Fittings: Hot-dipped galvanized, malleable iron with bonding jumpers.
1. Linear - O-Z/Gedney Type AX or TX.
 2. Linear with deflection - O-Z/Gedney Type AXDX.
- Q. Escutcheons: Chrome-plated sectional floor and ceiling plates, Crane No. 10.
- R. Accessories: Reducers, bushings, washers, etc., shall be cadmium-plated, malleable iron of the forms and dimensions best suited for the application.
- S. Identifying Tape for Buried Conduits: 6 in. wide, polyethylene, with printing continuous along length of tape, Brady Identoline.
1. For buried electric power conduits- red with black letters.
 2. For buried electric communication conduits - orange with black letters.

PART 3 - EXECUTION

3.1 INSTALLATION

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

- M. Install and neatly rack exposed conduits parallel with and perpendicular to building walls. Provide space for 25% additional conduit. Do not install exposed diagonal conduit runs.
- N. Route and suspend conduits crossing expansion joints to permit expansion, contraction, and deflection utilizing approved fittings to prevent damage to the building, conduits, and supporting devices.
- O. Do not install conduits exposed on the roof unless approval is obtained prior to installation.
- P. Route conduit through roof openings for piping and duct-work where possible; otherwise, route through roof penetration system as specified in Section 26 05 27 - SEALING OF PENETRATIONS.
- Q. Do not place conduits in close proximity to equipment, systems and service lines, such as hot water supply and return lines, steam pipes, which could be detrimental to the conduit and its contents. Maintain a minimum of 3 in. separation, except in crossing, which shall be a minimum 1 in.
- R. Connect motors, equipment containing motors, equipment mounted on isolated foundations, transformers and other equipment and devices which are subject to vibration and which require adjustment, with flexible metallic conduit from the device to the conduit serving it. Restrict length of flexible conduit to 6 ft. maximum unless specifically instructed in writing otherwise by the Architect. Provide secure supports at the points of attachment on each side of the connection. Use bonding jumpers as directed by the National Electrical Code and other sections of these specifications.
- S. Install escutcheons on sight exposed conduits passing through interior floors, walls, and ceilings in finished spaces
- T. Install fire seals on conduits passing through fire-rated partitions, floors and ceiling.
- U. Install through-wall seals on conduits passing through exterior walls or use standard galvanized steel pipe sleeves, diameters 1/2 in. greater than the outside diameter of the sleeved conduit and fill the annular space with mastic.
- V. Install sleeves for conduits passing through interior floors.
- W. Install insulated throat grounding bushings on conduits stubbed through slabs and foundations into electrical enclosures.
- X. Provide grounding of conduits, fittings and accessories. Refer to grounding section of specifications.
- Y. Feeder Circuits:
 - 1. Install rigid metal conduit in damp and wet locations, in concrete slabs, and where exposed in mechanical and electrical equipment rooms and crawl spaces.
 - 2. Install flexible metal conduit where specified above and where permitted by the authorities having jurisdiction. Use liquid tight flexible metal conduit in damp and wet locations, where exposed in mechanical and electrical equipment rooms, and in kitchen and shop areas.

3. Exterior to the building and below grade, bury Schedule 40 nonmetallic conduit, where permitted by the authorities having jurisdiction. If not permitted, use rigid steel conduit in accordance with installation requirements stated below. Elbows and bends greater than 30 degrees shall be rigid steel with PVC coating or wrapped with half-lapped, 0.20 inch thick, self-sticking, anti-corrosive PVC pipe wrapping tape. Vertical extensions from the elbow to above grade or slab shall be rigid steel with PVC coating or wrapping tape.
4. Exterior to the building and above grade, use rigid steel conduit and for elbows and bends greater than 30 degrees.

Z. Branch Circuits:

1. Install rigid metal conduit in damp and wet locations, in concrete slabs, and where exposed in crawl space.
2. Install electrical metallic tubing where concealed by building structure and where exposed in mechanical and electrical equipment rooms.
3. Exterior to the building and below grade, bury Schedule 40 nonmetallic conduit, where permitted by the authorities having jurisdiction. If not permitted, use rigid steel conduit in accordance with installation requirements stated below. Elbows and bends greater than 30 degrees shall be rigid steel with PVC coating or wrapped with half-lapped, 0.20 inch thick, self-sticking, anti-corrosive PVC pipe wrapping tape. Vertical extensions from the elbow to above grade or slab shall be rigid steel with PVC coating or wrapping tape.
4. Exterior to the building and above grade, use rigid steel conduit and for elbows and bends greater than 30 degrees.
5. Install flexible metal conduit where specified above and where permitted by the authorities having jurisdiction. Use liquid tight flexible metal conduit in damp and wet locations, where exposed in mechanical and electrical equipment rooms, and in kitchen and shop areas. Limit flexible conduit to a length of 6 ft. maximum unless specifically instructed otherwise, in writing, by the Architect.

END OF SECTION

SECTION 26 05 34

OUTLET BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 OUTLET BOXES

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

PART 3 - EXECUTION

3.1 COORDINATION OF BOX LOCATIONS

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

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

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

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

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

3.2 OUTLET BOX INSTALLATION

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

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

END OF SECTION

SECTION 26 28 16

OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FUSES

- A. Fuses shall be current-limiting, with 200,000 RMS symmetrical amperes interrupting rating and shall be UL listed. All fuses shall be of same manufacturer.
- B. Fuses over 600 amperes shall be Class L, bolt-on type, with time-delay and hold 500 percent rated fuse current for minimum of 4 seconds and clear 20 times rated fuse current in .01 seconds or less. Fuses shall have 'O' ring seals between end bells and glass melamine barrel, equivalent to Bussmann time delay KRP-C.
- C. Fuses 600 amperes and smaller shall be Class RK1, dual element. These fuses shall have separated overload and short-circuit elements. The overload, time-delay element shall be spring activated and utilize a eutectic alloy with a 284-degree F. melting point. The fuse shall hold 500 percent of its rated fuse current for a minimum of 10 seconds, equivalent to Bussmann dual-element LPN-RK (250 volts or less rating) and LPS-RK (600 volts or less rating).
- D. Fuses in motor circuits shall be changed, if necessary, as follows: Fuses for not less than 1.15 service factor motors shall have an ampere rating 125 percent of motor full load current or next higher fuse rating. Fuses for 1.0 service factor motors shall have an ampere rating 115 percent of motor full load current or next higher fuse rating. Use special fusing sizing considerations where motors are subjected to high ambient temperatures, where the motor drives an inertia load causing starting current to be prolonged, where on-off cycles less than 30 minutes, or where special hermetically sealed motors have unusual starting characteristics. When a physically smaller fuse is required in a switch, then the fuse clips must be changed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install overcurrent devices in accordance with the National Electrical Code. Coordinate the work under this section with the work under other divisions of the specifications.
- B. Do not share neutral conductors between circuits protected by arc fault circuit interrupters.
- C. Fuses shall be installed in all switches as scheduled or noted on the Drawings, and shall be Bussman, Mersen, Littelfuse, Inc., or an approved equivalent.
- D. Unless otherwise indicated, protective devices shall be mounted with top of cabinet or enclosure 6 ft. 6 in. above finished floor, properly aligned, and adequately supported independently of the connecting raceways. All steel shapes, etc., necessary for the support of the equipment shall be furnished and installed where the building structure is not suitable for mounting the equipment directly thereon.
- E. A fuse identification label showing type and size shall be placed inside the door of each fused switch.
- F. Circuit breaker pick-up level and time delay settings shall be adjusted to values indicated on the drawings.

END OF SECTION

SECTION 26 28 17

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION

SECTION 26 29 13

MOTORS, MOTOR STARTERS AND CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 SUBMITTALS

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

1.3 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 OVERCURRENT PROTECTION

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

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

3.3 ELECTRICAL CONNECTIONS

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

3.4 EQUIPMENT IDENTIFICATION

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

END OF SECTION