SECTION 23 01 00

GENERAL HVAC PROVISIONS

PART 1 GENERAL

1.1 WORK INCLUDED

A. The work covered by Division 23 sections consist of furnishing all labor, equipment, appliances and material for the heating, air conditioning, piping and plumbing systems in strict accordance with Codes, Specifications and the applicable drawings and subject to the terms and conditions of the contract. Include all appurtenances necessary to the proper operation of the systems and equipment specified.

B. General Contractor shall install all concrete pads and bases required for installing mechanical equipment. Mechanical Contractor is responsible for the exact sizes required, location of anchor bolts, etc.

C. Mechanical Contractor shall furnish and install roof-mounted air handler and exhaust fan bases and shall be the manufacturer's base.

D. Some equipment may be furnished by other divisions. Mechanical Contractor is responsible to check the drawings and specifications for equipment that will be furnished by the Owner. Furnish the duct, insulation, controls, etc., on all equipment furnished by other divisions.

E. General Contractor shall furnish and install all ceiling access panels required to service mechanical equipment, valves and controls above gyp board or hidden spline ceilings.

1.2 RELATED SECTIONS

A. The General Conditions and Division 1, General Requirements, as bound in the specification preamble, apply to all work under Division 23. Carefully note its contents in performance of the work.

B. The Architectural, Fire Suppression, Plumbing, Electrical, and Structural plans and Specifications, including Information to Bidders and other pertinent documents issued by the Engineer are a part of this Specifications and the accompanying mechanical plans. Comply with them in every respect. Examine all the above carefully. Failure to comply does not relieve the Contractor of responsibility nor may it be used as a basis for additional compensation due to omission of architectural, electrical and structural details from the mechanical drawings.

C. All electrical power wiring is specified under Division 26 of the Specifications. Mechanical Contractor shall furnish all motor starters required for the control and protection of all motors furnished for the Division 23. Provide and install all automatic temperature and interlock wiring required for controlling mechanical equipment furnished under Division 23, in compliance with Division 26 of the Project Manual.

D. All concrete pads and bases required for installing mechanical equipment are specified in another section of the Specifications. Advise the General Contractor as to the exact sizes required, location of anchor bolts, etc.

E. Paint all mechanical equipment, piping, supports and other exposed material. Do not paint indoor equipment supplied with painted finish, such as the main mechanical equipment unless damaged during handling and installation. In such cases, use touch-up paint of the same type and color as original paint. Conform to requirements in other sections of the Specifications and match wall finish to the room in which installed.

1.3 CODES, FEES AND LATERAL COSTS

A. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations, and the applicable requirements of the following latest nationally accepted codes and standards:

1. Myrtle Beach, South Carolina City Building Code; latest accepted edition.
2. South Carolina State Mechanical Code; latest accepted edition.
3. South Carolina State Plumbing Code; latest accepted edition.
4. South Carolina Energy Code; latest accepted edition.
5. IBC - International Building Code; latest accepted edition.
6. IFC - International Fire Code; latest accepted edition.
7. IGC - International Gas Code; latest accepted edition.
8. IMC - International Mechanical Code; latest accepted edition.
9. IPC - International Plumbing Code; latest accepted edition.
10. IECC - International Energy Conservation Code
11. AMCA - Air Moving & Conditioning Association.
12. ASA - American Standards Association.
13. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers.
14. ASME - American Society of Mechanical Engineers.
15. ASTM - American Society of Testing Materials.
16. AWWA - American Water Works Association.
17. NBS - National Bureau of Standards.
18. NEMA - National Electrical Manufacturers Association.

19. NFPA - National Fire Protection Association.

20. SMACNA - Sheet Metal & Air Conditioning Contractors' National Association.

21. UL - Underwriters' Laboratories, Inc.

22. AGA - American Gas Association.

23. OSHA - Occupational Safety and Hazard Association.

24. AABC - Associated Air Balance Councils

25. NEBB - National Environmental Balancing Bureau

B. Comply with State of South Carolina adopted ADA Accessible Guidelines in regard to accessible or handicapped features.

C. In case of difference between building codes, Specifications, state Laws, local ordinances, industry standards and utility company regulations and the Contract Documents, the most stringent governs. Promptly notify the Engineer in writing of any such difference.

D. Remove any work installed that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards, or utility company regulations, correct the deficiencies, and reinstall all work at no cost to the Owner.

E. The mechanical drawings show the general arrangement of all piping, equipment and appurtenances. Follow as closely as actual building construction and the work of other trades will permit. Final layout will be governed by actual field conditions with all measurements verified at the site. Conform to the requirements shown on all of the drawings. General and structural drawings take precedence over mechanical drawings. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate the existing and finish conditions affecting the work and arrange the work accordingly, providing such fittings, valves and accessories as may be required to meet such conditions. Contractor shall verify that all equipment, ducts, pipes and all other components will fit in the space provided before fabrication or ordering.

F. Obtain any and all required permits in connection with this work under the Contract and pay any and all fees in connection therewith. Arrange with the serving utility companies for the connections to all utilities and pay all charges for same including inspection fees and meters if required. Refundable deposits will be paid by the Owner.

G. Mechanical Contractor shall provide and install, where applicable, seismic restraints for all piping and duct systems per the latest accepted Building Code.

1.4 GUARANTEE

A. Furnish a written certificate guaranteeing all materials, equipment and labor furnished to be free of all defects for a period of one (1) year from and after the date of final acceptance of the

work by the Owner and further guarantee to replace such work without charges if any defects appear within the stipulated guaranty period.

1.5 SOIL CONDITIONS

A. The Specifications and the drawings in no way imply the conditions of the soil to be encountered. When excavating may be required in execution of the work, this Contractor agrees that he has informed himself regarding conditions affecting the work.

1.6 INSPECTION OF PREMISES

A. Before submitting a bid, visit the site of the proposed job and determine the conditions relating to this work.

1.7 UTILITIES, LOCATIONS AND ELEVATIONS

A. Locations and elevations of the various utilities included within the scope of this work have been obtained from substantially reliable sources and are offered as a general guide only, without guarantee as to accuracy. Verify the location and elevation of all utilities and their relation to the work before entering into a contract.

1.8 EXISTING BUILDING AND EXISTING MECHANICAL EQUIPMENT

A. Visit the existing building and become thoroughly acquainted with the existing physical plant, mechanical systems and utilities in order to determine all of the work that will be necessary to carry out the intent of the plans and specifications.

B. If it is necessary, in any way, to interfere with normal operations of the existing utilities in order to carry out the work, give notice and obtain written approval from the Owner before the work is started.

C. The work involved in this project requires the Contractor to work inside of an existing building. Interruption of the regular routine of the building by the Contractor must be kept to a minimum.

1.9 EQUIPMENT NOT SPECIFIED UNDER DIVISION 23

A. Equipment which requires plumbing and other mechanical connections may be specified in another division of this Specification. Under these conditions, provide necessary utilities including waste, water, natural gas, duct, insulation and controls.

B. Rough-in work from approved shop drawings only.

PART 2 PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Provide new materials bearing the manufacturer's name, trade name and the UL label in every case where a standard has been established for the particular material. Furnish the standard

product of a manufacturer regularly engaged in the production of the required type of equipment. Provide the manufacturer's latest approved design.

B. Deliver equipment and materials to the site and store in original containers, suitably sheltered from the elements, but readily accessible for inspection by the Engineer until installed. Store all items subject to moisture damage (such as controls) in dry, heated spaces.

C. Provide equipment and materials of the same general type and of the same make throughout the work to provide uniform appearance, operation and maintenance.

D. Tightly cover equipment and protect against dirt, water and chemical or mechanical injury and theft. At the completion of the work, clean fixtures, equipment and materials and polish thoroughly. Turn over to the Owner in a condition satisfactory to the Engineer. Repair damage or defects developing before acceptance of the work at no expense to the Owner.

E. Insure that items to be furnished fit the space available. Make necessary field measurements to ascertain space requirements, including those for connections. Furnish and install such sizes and shapes of equipment that the final installation suits the true intent and meaning of the drawings and Specifications.

F. Follow manufacturer's directions completely in the delivery, storage, protection and installation of all equipment and materials. Promptly notify the Engineer in writing of any conflicts between any requirements of the Contract Documents and the manufacturers' directions. Obtain the Engineer's written instruction before proceeding with the work. Replace any work that does not comply with the manufacturers' directions or such written instructions from the Engineer, at no cost to the Owner.

G. Support all products by service organizations with adequate spare parts inventory and personnel located reasonably close to the site.

H. Where multiple units of the same type or class of products are required, provide all units of the same manufacturer.

2.2 EQUIPMENT ACCESSORIES

A. Furnish and install all equipment, accessories, connections and incidental items necessary to fully complete all work, ready for use, occupancy and operation by the Owner.

B. Where equipment requiring different arrangement or connections from those shown is provided, install the equipment to operate properly and in harmony with the intent of the drawings and Specifications.

C. Support, plumb, rigid and true to line, all work and equipment furnished. Study thoroughly all general, structural, electrical, fire suppression and mechanical drawings, shop drawings and catalog data to determine how equipment, fixtures, piping, ductwork, etc., are to be supported, mounted or suspended and provide extra steel bolts, inserts, pipe stands, brackets and

accessories for proper supports whether or not shown on the drawings. When directed, submit drawings showing supports.

D. If accessories are required to complete the work and meet the intent of the specification, it is the responsibility of the Contractor to provide such accessories.

2.3 MATERIAL AND EQUIPMENT SCHEDULE

A. Submit to the Engineer as soon as practical, six (6) complete sets of the schedule of materials and equipment proposed for the installation, or electronic submittals as detailed below. Include manufacturers' names, catalog data, diagrams, drawings and other descriptive data and submit under one cover with an index sheet in front.

1. If Electronic files are submitted, a complete set of the schedule of materials and equipment proposed for the installation shall be included. Include manufacturers' names, catalog data, diagrams, drawings and other descriptive data. All information shall be submitted electronically in "pdf" format, and shall be separated into electronic "pdf" files according to the corresponding specification section (i.e. "23 40 00 - Air Cleaning Devices.pdf"). Unless incomplete submittals are authorized by the project engineer, all Division 23 submittals shall be electronically sent at one time. Without authorization, incomplete submittals shall be rejected.

B. Provide written certification that shop drawings are in accordance with the specifications and are dimensionally correct with reference to available space.

C. All submittals will be reviewed a maximum of two (2) times. The cost of additional submittal reviews beyond those two specified will be charged to the Contractor.

D. Shop drawings for the Engineer's files are required on the following items:

1. Packaged Rooftop Unit.
2. Air Terminal Units.
3. Humifiers.
4. Electric Wall Heaters.
5. Mini-Split HVAC Units.
6. Filters.
7. Wall Louvers.
8. Exhaust Fans.
9. Grilles and Registers.
10. Controls and Instrumentation.
11. Air Balance Certification.

12. Ductwork Materials Including Duct Accessories.

13. Duct Insulation Materials.

14. Complete Mechanical Equipment Electrical Data and Wiring Details.

15. Variable Frequency Drives.

16. Spiral Duct.

17. Seismic Restraints.

18. Controls - Including Sequences of Operation specific to the job.

2.4 EQUIPMENT AND MATERIAL SUBSTITUTIONS

A. It is the responsibility of the Contractor to investigate any desired substitutions for specified equipment prior to submission of his bid. The Mechanical Contractor shall be responsible for any changes required in mechanical, electrical, structural or vibration isolation systems and shall bear all cost for those changes whether the substitute equipment is named by manufacturer in the specifications or is submitted to the Architect for "or equal" consideration. All changes shall be accomplished in a manner acceptable to the Architect per Section 01 60 00 at no additional cost to the Owner.

B. In order to obtain prior approval on equipment or material not specified in Division 23 Specifications or Equipment Schedules, Mechanical Contractor MUST submit to the Engineer any proposed equipment or material ten (10) working days prior to the bid date.

C. If ANY substitute equipment is submitted to Engineer for approval, without said equipment having been pre-approved, the entire submittal will be rejected for resubmittal.

D. Any equipment manufacturers which are a subsidiary to the listed acceptable manufacturers are not considered equal. Therefore, it is the responsibility of the Contractor and equipment supplier to obtain prior approval as described in paragraph 2.4, this Section.

2.5 ELECTRICAL MOTORS

A. Provide motors of a recognized manufacturer, wound for the voltage specified, and in conformance to latest standards of the manufacturer and performance of the National Electrical Manufacturers Association and the Institute of Electrical and Electronic Engineers. Provide motors as manufactured by General Electric, Westinghouse, Century or Siemens-Allis, Baldor or approved equal.

B. Provide motors rated for continuous duty at 100% of rated capacity and temperature raise of 40 degrees Centigrade open type; 50 degrees Centigrade drip and splash proof; 55 degrees Centigrade explosion proof and totally enclosed above an ambient of 40 degrees Centigrade.

C. Unless otherwise required, provide integral horsepower, polyphase motors, Class B, general purpose, squirrel cage, open type induction motors, T-frame.

D. Provide single phase fractional horsepower motors of the open capacitor type. Generally, motors under 1/2 horsepower may be split phase type unless otherwise specified. Provide motors rated 1/2 horsepower or less with integral overcurrent protection.

E. Insure the insulation resistance between stator conductor and frames of motors is not less than 1/2 megohm. Provide shop test of motors including temperature rise, insulation resistance, motor terminal voltage, normal operating line current, RPMs, breaker or switch size with fusing and overload relay sizes.

PART 3 EXECUTION

3.1 COORDINATION OF WORK

A. Compare the mechanical drawings and Specifications with the drawings and Specifications for other trades and report any discrepancies between them to the Engineer and obtain from him written instruction for changes necessary in the mechanical work. Install the mechanical work in cooperation with other trades installing inter-related work. Before installation, make proper provisions to avoid interferences in a manner approved by the Engineer. Make all changes required in the work caused either by neglect or existing field conditions at no cost to the Owner.

B. It is the responsibility of the General Contractor, Plumbing Contractor, Mechanical Contractor and Electrical Contractor, and Sprinkler Contractorto coordinate installation of all equipment. Equipment installed prior to proper coordination, which interferes with the harmony and intent of the specifications and drawings, will be removed and reinstalled at the cost of the responsible Contractor.

C. Furnish anchor bolts, sleeves, inserts and supports required for the mechanical work. Locate anchor bolts, sleeves, inserts and supports as directed by the trade requiring them and insure that they are properly installed.

D. Slots, chases, openings and recesses in existing structure shall be cut, patched and repaired by the Contractor.

E. Adjust locations of pipes, ducts, equipment fixtures, etc., to accommodate the work and for interferences anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.

1. Provide right-of-way to lines that pitch over those that do not pitch. For example, Plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have the right-of-way over lines whose elevations can be changed.

2. Make offsets, transitions and changes in direction in pipes and ducts as required to maintain proper head room and pitch.

F. Install all mechanical work to permit removal without damage to other parts, to coils, fan shafts and wheels, filters, belt guards, sheaves and drives and all other parts requiring periodic

replacement or maintenance. Arrange pipes, ducts and equipment to permit ready access to valves, cocks, traps, starters, motors, control components and to clear the openings of swinging and overhead doors and of access panels.

G. Change the cross sectional dimensions of ductwork when required to meet job conditions, but maintain at least the same equivalent cross sectional area. Secure the approval of the Engineer prior to fabrication of ductwork requiring such changes. Sizes shown on the plans are clear dimensions; add for internal insulation if specified.

3.2 RECORD DRAWINGS

A. Maintain record drawings showing exact locations and sizes, as actually installed, of piping, drains, cleanouts, ductwork, controls and equipment as specified herein. Deliver to the Owner/Architect upon completion and acceptance of the work, one (1) complete set of contract drawings marked to indicate all deviations from intended installation.

B. Record drawings shall be provide in hard copy form, as well as, on a DVD in PDF form.

3.3 CUTTING AND PATCHING

A. The General Contractor shall be responsible for all required cutting, patching, etc., incidental to this work and shall make all required repairs thereafter to the satisfaction of the Engineer. Do not cut into any major structural element, beam or column without the written approval of the Engineer.

B. Openings in fire or smoke barriers for air handling ductwork or air movement shall be protected in accordance with NFPA 90A and 90B and the Mechanical Code.

C. Pipes, conduits, cables, wires, air ducts, pneumatic tubes and ducts and similar handling service equipment that pass through fire or smoke barriers shall be protected in accordance with NFPA 101.

D. All fire stopping assemblies must be UL approved assemblies.

3.4 EQUIPMENT START-UP AND TESTING

A. Instruct the Owner's operating personnel during start-up and separate operating tests of each major item of equipment. During the operating tests, prove the operation of each item of equipment to the satisfaction of the Engineer. Give at least seven (7) days notice to the Engineer of equipment start-up and operating tests.

B. Refer to Section 23 08 00 for additional information.

3.5 CATALOG DATA FOR OWNER

A. Provide, in looseleaf binders, two (2) sets of a compilation of catalog data of each manufactured item of equipment used in the mechanical work and present this compilation to the Owner/Architect for transmittal to the Owner before final payment is made. Include

descriptive data and printed installation, operating and maintenance instructions for each item of equipment. Provide a complete double index as follows:

1. Listing of products alphabetically by name.
2. Listing the names of manufacturers whose products have been incorporated in the work alphabetically together with their addresses and the names and addresses of the local sales representatives.
3. Certificates of Final Inspections.
4. Complete spare parts data with current prices and supply sources.
5. Extended warranties.

B. Deliver to the Owner all special tools, lubricants, extra materials and any other products necessary for the proper operation and maintenance of the mechanical and plumbing systems.

C. Provide project record documents indicating all changes from contract documents made during construction.

D. Submit all Certificates of Final Inspections from the Administrative Authorities.

E. Submit TAB reports on approved forms. Final TAB report submittals shall include all required rebalances if any are required.

3.6 INSTRUCTION OF OWNER'S REPRESENTATIVE

A. Instruct the representative of the Owner in the proper operation and maintenance of all elements of the mechanical system. Spend not less than five (5) days in such formal instruction and additional time as directed by the Engineer to fully prepare the Owner to operate and maintain the mechanical equipment.

B. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated. Provide the following training as required to fully qualify the Owner's designated personnel. All training must be video taped to a CD and a copy included in each operation and maintenance closeout manual.

1. HVAC Control System.
2. Rooftop Unit hours.
3. Humidifers hours.
4. Return Fan/Relief Fan. hours.
5. Air Terminal Units hours.
6. Split System AC or Heat Pumps hour.

3.7 PROTECTIVE COATINGS

A. Paint exterior surfaces of steel piping run in or through concrete floor fill, under tile floors or underground, and aluminum surfaces in contact with masonry, with one coat of acid resisting bituminous base paint.

B. Paint all exposed galvanized ducts behind grilles flat black.

3.8 NOISE CONTROL

A. It is intended that the mechanical systems as installed under this contract be free from objectionable noise when the system is operating. The system shall operate at noise levels below criteria recommended for the application by ASHRAE. Provide vibration isolation accessories and isolate equipment, pipeline, ductwork, etc., as required so as to insure an acceptable noise level in all of the mechanical systems.

3.9 CLEANING AND ADJUSTING

A. Do not allow waste material and rubbish to accumulate in or above the premises. After completion of this work, remove rubbish, tools, scaffolding and surplus materials from and about the building and leave all work clean and ready for use. Clean all equipment, pipes, valves and fittings of grease, metal cuttings and sludge. Repair any stoppage, discoloration or other damage to parts of the building, its finish or furnishings due to failure to properly clean the mechanical systems, without additional cost to the Owner. Adjust all automatic control devices for proper operation.

3.10 SYSTEM OPERATING TESTS

A. After the successful completion of all equipment start-up and test requirements, perform the following tests on the complete mechanical systems:

1. First Operating Test by Contractor: Prove the operation of the mechanical systems and of each individual item in the systems. Give at least 10 day prior notice to the Engineer of such tests. Adjust and set proper quantities to all items and equipment. Should any item of the systems fail to perform in an approved manner, repeat this test until approved by the Engineer. During this test, balance circulation of heating and cooling water to balancing cocks, valves, thermostats and similar Items to insure that the mechanical systems perform as intended.

2. Checking by Owner and Engineer: Following the successful completion of first operating tests by the Contractor, the Owner and the Engineer have the privilege of making such tests as they may desire during a period of three weeks to ascertain in detail if any corrections are to be made to the system. At the end of the testing by the Owner and the Engineer, the Engineer may direct the Contractor in writing to make such corrections to the systems as are within the scope of the contract.

3. Contractor's Corrections to Systems: Make all required corrections to the systems and notify the Engineer in wiring that the corrections outlined have been completed. Give at least seven (7) days notice of a final three-day operating test.

4. Three-Day Operating Test: Perform an operating test to the satisfaction of the Engineer for a period of three (3) days. Should any element of the systems not perform properly, make all required corrections and repeat the test until successfully performed.

    a. Submit the Form of Record proposed by the Contractor for the recording of all measurements to the Engineer for approval at least two weeks before the approved form will be required by the Contractor.

    b. Measurements: Make the following measurements at two-hour intervals (5 measurements per 8-hour day) during the three-day operating test.

        1. Electrical: Running amperes and voltage of each motor 3/4 horsepower or larger.

        2. Air temperatures in each heated or air conditioned space and outdoor temperatures.

    c. Instruments: Provide all instruments, materials and labor to perform the tests and to obtain and record the measurements specified herein, including the furnishing of all required record forms as approved by the Engineer. Submit for the Engineer's approval, complete shop drawings or catalog data for all instruments to be used for the three day operating test and obtain approval at least two weeks before the instruments will be required for test measurements.

    d. Report: Submit four (4) copies of a written report of the three-day operating test on the approved Form of Record to the Engineer for approval and subsequent transmittal to the Owner.

3.11 MOTOR CONTROL

A. General: Provide each motor 1/8 horsepower or larger with a suitable controller and devices that will perform the functions as specified for the respective motors, together with manual reset thermal overload, protection in each undergrounded conductor. Provide the controller either integral with circuit protective device or mounted in separate enclosure. Starters shall be Allen-Bradley, G.E., Westinghouse, Square D or approved equal.

B. Control: Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motor directly, provided the device used is designated for that purpose and has an adequate horsepower rating. When automatic control device does not have such a rating, use a magnetic starter with the automatic control device actuating the pilot control circuit. When combination manual and automatic control is specified and the control device operates the motor directly, provide a manual motor starter and selector switch. When combination manual and automatic control is specified and the automatic control device

actuates the pilot control circuit, a magnetic control device actuates the pilot control provided. Provide all magnetic starters with push buttons or selector switches in the covers. Provide connections to the selector switch such that only the normal automatic regulating control devices will be bypassed when the switch is in the manual position. Connect all safety control devices, such as low or high pressure cutouts, high temperature cutouts and motor overload protective devices in the motor control circuit in both the manual and automatic positions of the selector switch control circuit. Make connections to any selector switch or to more than one (1) automatic regulatory control device in accordance with wiring diagrams recommended by the manufacturer and approved by the Engineer. Where required for manual control, provide push-button stations consisting of two (2) momentary contact operators, 600 volts, 10 amperes installed and wired for three wire control to provide under-voltage relays, auxiliary contacts or other devices required for a complete system.

C. Location: Where the controller is located within sight of the motor driven equipment (fifty feet or less), the controller and circuit protective device shall be capable of being locked in the open position. Where the controller is located out of sight of the motor driven equipment (more than fifty feet) provide a non-fused safety disconnect, suitable for the service, and which opens all ungrounded conductors simultaneously, at or on the motor driven equipment.

D. Enclosure: Enclosure to be general purpose, NEMA Type 1 unless noted otherwise (NEMA Type 1 gasketed). The circuit breaker shall be operable by hand from outside the enclosure and shall be so interlocked with the door or doors that it must be returned to the "OFF" position before the door can be opened.

E. Push-buttons: Provide maintained contact, standard duty type in a general purpose, NEMA Type 1 enclosure for surface mounting rated for 10 amperes continuous at 600 volts or less.

3.12 ACCESS PANELS

A. Provide access panels as required in all walls, ceilings and ductwork to service and have access to all valves, operating parts and duct mounted fire dampers. For all ceiling and wall access doors that are required in gypsum board and plaster, provide minimum 24" x 24", unless due to structural restraints the access door can be reduced to a minimum of 18" x18", Milcor type appropriate for the construction involved.

3.13 TEMPORARY HEATING AND COOLING

A. Permanent heating and cooling systems may be used to provide temporary heating and cooling to the building during construction, if the following requirements are met:

1. Provide filters in equipment filter racks.

2. Provide filter material at entrance to all return air ducts or over permanent return air grilles. All return air ductwork is to be protected from construction dust and debris. If return air duct work is not protected prior to equipment startup for temporary use, the Contractor will pay to have the entire ductwork system of the affected equipment thoroughly cleaned prior to Owner occupancy.

3. Contractor shall provide and pay for operation, maintenance, regular replacement of filters and worn or consumed parts.

4. shall replace any equipment that is damaged during temporary usage with new equipment.

5. All warranty periods shall not begin until Certificate of Substantial Completion is issued.

6. Verify with engineer that the installation is ready and approved for operation.

B. Just prior to turning the building or portions of the building over to the Owner, Contractor will replace all filters on equipment used for temporary ventilation, heat or cooling during construction.

C. Do not turn water into the system until the systems have been thoroughly cleaned and approved by the Engineer.

3.14 FINALLY

A. It is the intention that this specification shall provide a complete installation except as herein before specifically excepted. All accessory construction and apparatus necessary or advantageous in the operation and testing of the work shall be included. The omission of specific reference to any part of the work necessary for such complete installation shall not be interpreted as relieving this Contractor from furnishing and installing such parts.

END OF SECTION

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Vibration isolation requirements.

B. Seismic control requirements.

1. Includes requirements for seismic qualification of equipment not specified in this section.

C. Equipment support bases.

D. Vibration isolators.

E. External seismic snubber assemblies.

F. Seismic restraint systems.

G. Vibration-isolated and/or seismically engineered roof curbs.

1.2 RELATED REQUIREMENTS

A. Section 21 05 48 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.

B. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.3 DEFINITIONS

A. HVAC Component: Where referenced in this section in regards to seismic controls, applies to any portion of the HVAC system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g. ductwork, piping).

B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.4 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2010, with 2013 Supplements and Errata.

B. ASCE 19 - Structural Applications of Steel Cables for Buildings; 2016.

C. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; 2015.

D. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment; 2002.

E. FEMA 413 - Installing Seismic Restraints for Electrical Equipment; 2004.

F. FEMA 414 - Installing Seismic Restraints for Duct and Pipe; 2004.

G. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage; 2011.

H. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. MFMA-4 - Metal Framing Standards Publication; 2004.

J. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association; 2008.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.

2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Seismic Controls:

a. Coordinate the arrangement of seismic restraints with piping, conduit, equipment, and other potential conflicts installed under other sections or by others.

b. Coordinate the work with other trades to accommodate relative positioning of essential and non-essential components in consideration of seismic interaction.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.6 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. All seismic / wind / vibration/seismic restraint systems shall be by a single manufacturer.

C. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.

1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities.

2. Seismic Controls: Include seismic load capacities.

E. Shop Drawings - Vibration Isolation Systems:

1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.

2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.

F. Shop Drawings - Seismic Controls:

1. Include dimensioned plan views and sections indicating proposed HVAC component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.

2. Identify mounting conditions required for equipment seismic qualification.

3. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.

4. Indicate proposed arrangement of distributed system trapeze support groupings.

5. Indicate proposed locations for distributed system flexible fittings and/or connections.

6. Indicate locations of seismic separations where applicable.

G. Seismic Design Data:

1. Compile information on project-specific characteristics of actual installed HVAC components necessary for determining seismic design forces required to design appropriate seismic controls, including but not limited to the following.

a. Component operating weight and center of gravity.

b. Component elevation in the building in relation to the roof elevation (z/h).

c. Component importance factor (Ip).

d. For distributed systems, component materials and connection methods.

e. Component amplification factor (ap) and component response modification factor (Rp), determined in accordance with ASCE 7 tables.

f. Applicability of overstrength factor (for certain anchorage in concrete and masonry).

2. Include structural calculations, stamped or sealed by seismic controls designer, demonstrating suitability of seismic controls for seismic design forces.

H. Evaluation Reports: For products specified as requiring evaluation and recognition by a qualified evaluation service, provide current evaluation reports.

I. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

J. Manufacturer’s detailed field testing and inspection procedures.

K. Field quality control test reports.

L. Shop Drawings:

1. Include the seal of the Professional Structural Engineer registered in the State of South Carolina in which the Project is located, on drawings and calculations which at a minimum include the following:

M. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.

N. Base submittals shall include equipment served, construction, coatings, weights, and dimensions

O. Product Data: Provide schedule of vibration isolator type with location and load on each.

P. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

Q. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.7 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Seismic Controls Designer Qualifications: Registered professional engineer licensed in South Carolina and with minimum five years experience designing seismic restraints for nonstructural components.

1. Designer may be employed by the manufacturer of the seismic restraint products.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

E. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATION REQUIREMENTS

A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.

B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:

C. General Requirements:

1. Select vibration isolators to provide required static deflection.

2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.

3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.

4. Select vibration isolators for outdoor equipment to comply with wind design requirements.

D. Equipment Isolation: As indicated on drawings.

E. Piping Isolation:

1. Minimum Static Deflection:

a. First Three Supports Closest to Isolated Equipment: Same as static deflection of equipment; maximum of 2 inch deflection required.

b. Remainder of Supports: 0.75 inch deflection unless otherwise indicated.

2. Suspended Piping, Non-Seismic Applications: Use resilient material isolator hangers, spring isolator hangers, or combination resilient material/spring isolator hangers.

3. Suspended Piping, Seismic Applications: Use seismic type resilient material isolator hangers, seismic type spring isolator hangers, or seismic type combination resilient material/spring isolator hangers.

4. Floor-Mounted Piping, Non-Seismic Applications: Use open (unhoused) spring isolators.

5. Floor-Mounted Piping, Seismic Applications: Use seismic type restrained spring isolators.

6. Use modular seal or approved resilient material where vibration-isolated piping penetrates building elements (e.g. walls, floors) arranged to prevent vibration transmission to structure.

F. Thrust Restraint Applications:

1. Use thrust restraints to resist horizontal motion due to thrust for fan heads, suspended fans, and base-mounted and suspended air handling equipment operating at 2.0 inches wg or greater total static pressure.

2. Minimum Static Deflection: Same as static deflection of equipment.

3. Limit lateral movement to 0.25 inch or less unless otherwise indicated.

2.2 SEISMIC CONTROL REQUIREMENTS

A. Design and provide HVAC component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor HVAC components.

B. Seismic Design Criteria: As indicated on drawings.

C. Component Importance Factor (Ip): HVAC components to be assigned a component importance factor (Ip) of 1.5 unless otherwise indicated.

D. Seismic Restraints:

1. Provide seismic restraints for HVAC components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.

2. Seismic Restraint Exemptions:

a. Exemptions for Seismic Design Category C:

1. HVAC components with component importance factor (Ip) of 1.0.

2. HVAC piping with component importance factor (Ip) of 1.5 and nominal pipe size of 2 inch or less; exemption does not apply to piping constructed of low-deformability materials (e.g. cast iron, glass, nonductile plastics).

b. Exemptions for Seismic Design Category D, E, and F:

1. HVAC components with component importance factor (Ip) of 1.0 where all of the following apply:

(a) The component is positively attached to the structure.

(b) Flexible connections are provided between the component and associated ductwork, piping, and conduit.

(c) Either:

(1) The component weighs 400 pounds or less and has a center of mass located 4 feet or less above the adjacent floor level.

(2) The component weighs 20 pounds or less or, in the case of a distributed system, 5 pounds per foot or less.

2. HVAC piping with component importance factor (Ip) of 1.0 and nominal pipe size of 3 inch or less, or with component importance factor (Ip) of 1.5 and nominal pipe size of 1 inch or less; exemption does not apply to piping constructed of low-deformability materials (e.g. cast iron, glass, nonductile plastics).

c. Ductwork Exemptions, All Seismic Design Categories:

1. Ductwork not designed to carry toxic, highly toxic, or flammable gases and not used for smoke control where any of the following apply:

(a) Trapeze supported ductwork weighing less than 10 pounds per foot.

(b) Hanger supported ductwork where each hanger in the duct run is 12 inches or less in length from the duct support to the supporting structure; rod hangers, where used, to be equipped with swivels.

(c) Ductwork having a cross sectional area of less than 6 square feet or weighing 17 pounds per foot or less, and where there are provisions to avoid impact with other ducts or mechanical components or to protect ducts in the event of such impact.

d. HVAC Piping Exemptions, All Seismic Design Categories:

1. Trapeze supported piping weighing less than 10 pounds per foot, where all pipes supported meet requirements for exemption as single pipes described under specific seismic design category exemptions above.

2. Hanger supported piping where each hanger in the piping run is 12 inches or less in length from the pipe support to the supporting structure; rod hangers, where used, to be equipped with swivels.

3. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:

   a. ASHRAE (HVACA).

   b. FEMA 412.

   c. FEMA 413.

   d. FEMA 414.

   e. FEMA E-74.

   f. SMACNA (SRM).

4. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third party registered professional engineer acceptable to authorities having jurisdiction.

5. Seismic Type Vibration Isolators:

   a. Comply with seismic design requirements, including conditions of equipment seismic certification where applicable.

6. External Seismic Snubber Assemblies:

   a. Provide quantity and arrangement of external seismic snubber assemblies as required to restrain equipment in all directions (both lateral and vertical).

   b. Do not use external seismic snubber assemblies that restrain equipment only in one or more lateral directions (but not vertical) except where uplift forces are zero or are addressed by other restraints.

7. Seismic Restraint Systems:

   a. Except where otherwise restricted, use of either cable or rigid restraints is permitted.

   b. Use only cable restraints to restrain vibration-isolated HVAC components, including distributed systems.

c. Use only one restraint system type for a given HVAC component or distributed system (e.g. ductwork, piping) run; mixing of cable and rigid restraints on a given component/run is not permitted.

d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain HVAC component in all lateral directions; consider bracket geometry in anchor load calculations.

e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported HVAC component weight.

f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported HVAC component weight.

g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.

h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.

i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.

8. Ductwork Applications:

a. Provide independent support and seismic restraint for in-line components (e.g. fans, heat exchangers, humidifiers) having an operating weight greater than 75 pounds.

b. Positively attach appurtenances (e.g. dampers, louvers, diffusers) with mechanical fasteners.

E. Seismic Attachments:

1. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.

2. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.

3. Do not use power-actuated fasteners.

4. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.

5. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.

6. Concrete Housekeeping Pads:

   a. Increase size of pad as required to comply with anchor requirements.

   b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.

F. Seismic Interactions:

1. Include provisions to prevent seismic impact between HVAC components and other structural or nonstructural components.

2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.

G. Seismic Relative Displacement Provisions:

1. Use suitable fittings or flexible connections to accommodate:

   a. Relative displacements at connections between components, including distributed systems (e.g. ductwork, piping); do not exceed load limits for equipment utility connections.

   b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.

   c. Design displacements at seismic separations.

   d. Anticipated drifts between floors.

2.3 MANUFACTURERS

A. Kinetics Noise Control, Inc.

B. Mason Industries.

C. Substitutions: See Section 23 01 00 - General HVAC Provisions.

2.4 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

A. Vibration-Isolated Structural Steel Bases:

1. Description: Engineered structural steel frames with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.

B. Vibration-Isolated Concrete Inertia Bases:

1. Description: Concrete-filled engineered steel forms with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.

2. Minimum Base Depth: 6 inches.

3. Minimum Base Mass (Including Concrete): 1.5 times weight of supported equipment.

4. Concrete Reinforcement: Welded or tied reinforcing bars running both ways in a single layer.

5. Concrete: Filled on site with minimum 3000 psi concrete in accordance with Section 03 30 00.

2.5 VIBRATION ISOLATORS

A. General Requirements:

1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.

2. Spring Elements for Spring Isolators:

a. Color code or otherwise identify springs to indicate load capacity.

b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.

c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.

d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.

e. Selected to provide designed deflection of not less than 75 percent of specified deflection.

f. Selected to function without undue stress or overloading.

3. Seismic Snubbing Elements for Seismic Isolators:

a. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.

b. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.

B. Vibration Isolators for Non-Seismic Applications:

1. Resilient Material Isolator Pads:

    a. Description: Single or multiple layer pads utilizing elastomeric (e.g. neoprene, rubber) or fiberglass isolator material.

    b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch thickness.

    c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.

2. Resilient Material Isolator Mounts, Non-Seismic:

    a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g. neoprene, rubber) or fiberglass isolator material; fail-safe type.

3. Open (Unhoused) Spring Isolators:

    a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) without a housing.

    b. Bottom Load Plate: Non-skid molded elastomeric isolator material or steel with non-skid elastomeric isolator pad with provisions for bolting to supporting structure as required.

    c. Furnished with integral leveling device for positioning and securing supported equipment.

4. Housed Spring Isolators:

    a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.

    b. Furnished with integral elastomeric snubbing elements, non-adjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.

    c. Bottom Load Plate: Steel with non-skid elastomeric isolator pad with provisions for bolting to supporting structure as required.

    d. Furnished with integral leveling device for positioning and securing supported equipment.

5. Restrained Spring Isolators, Non-Seismic:

    a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop.

b. Bottom Load Plate: Steel with non-skid elastomeric isolator pad with provisions for bolting to supporting structure as required.

c. Furnished with integral leveling device for positioning and securing supported equipment.

d. Provides constant free and operating height.

6. Resilient Material Isolator Hangers, Non-Seismic:

a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g. neoprene, rubber) or fiberglass isolator material for the lower hanger rod connection.

7. Spring Isolator Hangers, Non-Seismic:

a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection.

b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short circuiting of isolation.

8. Combination Resilient Material/Spring Isolator Hangers, Non-Seismic:

a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g. neoprene, rubber) or fiberglass isolator material for the upper hanger rod connection.

b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short circuiting of isolation.

9. Thrust Restraints:

a. Description: Assembly utilizing free-standing, laterally stable steel spring designed for resisting horizontal motion due to thrust (e.g. air pressure from a fan), and intended for installation in pairs.

C. Vibration Isolators for Seismic Applications:

1. Resilient Material Isolator Mounts, Seismic:

a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g. neoprene, rubber) isolator material; specifically designed and rated for seismic applications with integral snubbing in all directions.

2. Restrained Spring Isolators, Seismic:

a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) in series with elastomeric (e.g. neoprene, rubber) isolator material within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop; specifically designed and rated for seismic applications with integral snubbing in all directions.

b. Bottom Load Plate: Steel with provisions for bolting to supporting structure as required.

c. Furnished with integral leveling device for positioning and securing supported equipment.

d. Provides constant free and operating height.

3. Resilient Material Isolator Hangers, Seismic:

a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g. neoprene, rubber) isolator material for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.

4. Spring Isolator Hangers, Seismic:

a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.

b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short circuiting of isolation.

5. Combination Resilient Material/Spring Isolator Hangers, Seismic:

a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g. neoprene, rubber) isolator material for the upper hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.

b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short circuiting of isolation.

2.6 EXTERNAL SEISMIC SNUBBER ASSEMBLIES

A. Description: Steel snubbing assemblies designed for external attachment to both equipment and supporting structure that, as part of a complete system, restrain equipment motion in all

directions during a seismic event while maintaining vibration isolation during normal operation.

B. Seismic Snubbing Elements:

1. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.

2. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.

2.7 SEISMIC RESTRAINT SYSTEMS

A. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.

B. Cable Restraints:

1. Comply with ASCE 19.

2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.

3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.

4. Use protective thimbles for cable loops where potential for cable damage exists.

C. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

2.8 ROOF CURBS

A. Vibration Isolation Curbs:

1. Seismic Curb:

a. Location: Between structure and rooftop equipment.

b. Construction: Steel.

c. Integral vibration isolation to conform to requirements of this section.

d. Snubbers consist of minimum 0.25 inch thick resilient pads to avoid metal-to-metal contact without compromising vibration isolating capabilities.

e. Weather exposed components consist of corrosion resistant materials.

B. Seismic Type Non-Isolated Curb and Fabricated Equipment Piers:

1. Location: Between structure and rooftop equipment.

2. Construction: Steel.

3. Weather exposed components consist of corrosion resistant materials.

2.9 INERTIA BASES

A. Structural Bases:

1. Construction: Welded structural steel with gusseted brackets, to support equipment and motor, with motor slide rails.

2. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.

B. Concrete Inertia Bases:

1. Construction: Structural steel channel perimeter frame, with gusseted brackets and anchor bolts, reinforcing; concrete filled.

2. Mass: Minimum of 1.5 times weight of isolated equipment.

3. Connecting Point: Reinforced to connect isolators and snubbers to base.

4. Concrete: Minimum 3000 psi concrete.

2.10 VIBRATION ISOLATORS

A. Open Spring Isolators:

1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.

2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.

3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

B. Restrained Open Spring Isolators:

1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.

2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.

3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

4. Restraint: Provide heavy mounting frame and limit stops.

C. Spring Hangers:

1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.

2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.

3. Misalignment: Capable of 20 degree hanger rod misalignment.

D. Neoprene Pad Isolators:

1. Rubber or neoprene waffle pads.

a. Hardness: 30 durometer.

b. Thickness: Minimum 1/2 inch.

2. Configuration: Single layer.

E. Rubber Mount or Hanger: Molded rubber designed for 0.4 inch deflection with threaded insert.

F. Seismic Snubbers:

1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.

2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.

3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.

4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 CODE-REQUIRED SPECIAL INSPECTIONS

A. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.

1. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.

B. Seismic special inspections include, but are not limited to:

1. Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units for Seismic Design Categories C, D, E, and F; periodic inspection.

2. Installation and anchorage of ductwork designed to carry hazardous materials for Seismic Design Categories C, D, E and F; periodic inspection.

3. Installation and anchorage of vibration isolation systems for Seismic Design Categories C, D, E, and F where the approved contract documents require a nominal clearance of 1/4 inch or less between equipment support frame and seismic restraint; periodic inspection.

C. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Secure fasteners according to manufacturer's recommended torque settings.

D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

E. Vibration Isolation Systems:

1. Vibration-Isolated Equipment Support Bases:

a. Provide specified minimum clearance beneath base.

2. Spring Isolators:

a. Position equipment at operating height; provide temporary blocking as required.

b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.

c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.

3. Isolator Hangers:

a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.

b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.

4. Thrust Restraints:

a. Adjust restraint movement under normal operating static pressure.

5. Clean debris from beneath vibration-isolated equipment that could cause short circuiting of isolation.

6. Use elastomeric grommets for attachments where required to prevent short circuiting of isolation.

7. Adjust isolators to be free of isolation short circuits during normal operation.

8. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

F. Seismic Controls:

1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris, or other obstructions.

2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.

3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch, use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch or less.

4. Equipment with Sheet Metal Housings:

a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.

b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.

c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.

5. Concrete Housekeeping Pads:

a. Size in accordance with seismic design to meet anchor requirements.

b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.

6. Seismic Restraint Systems:

a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.

b. Install restraints within permissible angles in accordance with seismic design.

c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.

d. Install cable restraints for vibration-isolated components slightly slack to prevent short circuiting of isolation.

e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.4 FIELD QUALITY CONTROL

A. Inspect vibration isolation and/or seismic control components for damage and defects.

B. Provide services of a manufacturer's authorized representative for vibration isolation systems and seismic controls to perform inspection and testing. Include manufacturer's detailed testing and inspection procedures and field reports with submittals.

C. Vibration Isolation Systems:

1. Verify isolator static deflections.

2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.

D. Seismic Controls:

1. Verify snubbing element air gaps.

E. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

F. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe markers.

E. Ceiling tacks.

1.2 REFERENCE STANDARDS

1.3 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number. Valve locations with tag numbers shall also be indicated on "as-built" drawings.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Automatic Controls: Tags. Key to control schematic.

C. Control Panels: Nameplates.

D. Dampers: Ceiling tacks, where located above lay-in ceiling.

E. Ductwork: Stencilled painting.

F. Heat Transfer Equipment: Nameplates.

G. Instrumentation: Tags.

H. Piping: Tags.

I. Relays: Tags.

J. Small-sized Equipment: Tags.

K. Thermostats: Nameplates.

L. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.2 NAMEPLATES

A. Manufacturers:

1. Advanced Graphic Engraving.

2. Kolbi Pipe Marker Co.

3. Seton Identification Products.

4. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Description: Laminated three-layer plastic with engraved letters.

1. Letter Color: White.

2. Letter Height: 1/2 inch.

3. Background Color: Black.

4. Plastic: Conform to ASTM D709.

2.3 TAGS

A. Manufacturers:

1. Advanced Graphic Engraving.

2. Brady Corporation.

3. Kolbi Pipe Marker Co.

4. Seton Identification Products.

5. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame. Valve tag chart should should indicate valve size, valve model and valve location. Valve locations with tag numbers shall also be indicated on "as-built" drawings.

2.4 STENCILS

A. Manufacturers:

1. Brady Corporation.

2. Kolbi Pipe Marker Co.

3. Seton Identification Products.

4. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.

2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.

3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.

4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.

5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.

6. Ductwork and Equipment: 2-1/2 inch high letters.

2.5 PIPE MARKERS

A. Manufacturers:

1. Brady Corporation.

2. Kolbi Pipe Marker Co.

3. MIFAB.

4. Seton Identification Products.

5. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Color: Conform to ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

F. Color code as follows:

1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2. Toxic and Corrosive Fluids: Orange with black letters.

2.6 CEILING TACKS

A. Manufacturers:

1. Marking Services Incorporated.

2. Seton.

3. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Description: Steel with 3/4 inch diameter color coded head.

C. Color code as follows:

1. Yellow - HVAC equipment.

2. Red - Fire dampers/smoke dampers.

3. Blue - Heating/cooling valves.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 91 00 for stencil painting.

3.2 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

E. Use tags on piping 3/4 inch diameter and smaller.

1. Identify service, flow direction, and pressure.

2. Install in clear view and align with axis of piping.

3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

F. Install ductwork with stencilled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Measurement of final operating condition of HVAC systems.

1.2 REFERENCE STANDARDS

A. AABC MN-1 - National Standard for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems; Associated Air Balance Council; 2002.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; 2005, Seventh Edition.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.3 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

1. Submit to Architect.

2. Submit six weeks prior to starting the testing, adjusting, and balancing work.

3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.

4. Include at least the following in the plan:

a. Preface: An explanation of the intended use of the control system.

b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

d. Identification and types of measurement instruments to be used and their most recent calibration date.

e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

f. Final test report forms to be used.

g. Detailed step-by-step procedures for TAB work for each system and issue, including:

    1. Terminal flow calibration (for each terminal type).

    2. Diffuser proportioning.

    3. Branch/submain proportioning.

    4. Total flow calculations.

    5. Rechecking.

    6. Diversity issues.

h. Expected problems and solutions, etc.

i. Criteria for using air flow straighteners or relocating flow stations and sensors ; analogous explanations for the water side.

j. Details of how TOTAL flow will be determined; for example:

    1. Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.

k. Confirmation of understanding of the outside air ventilation criteria under all conditions.

l. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).

m. Method of checking building static and exhaust fan and/or relief damper capacity.

n. Methods for making coil or other system plant capacity measurements, if specified.

o. Time schedule for TAB work to be done in phases (by floor, etc.).

p. Description of TAB work for areas to be built out later, if any.

q. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.

r. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).

s. Procedures for formal progress reports, including scope and frequency.

t. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Logs: Submit at least once a week to Construction Manager and Engineer. Field logs should be submitted with weekly progress reports and include a record of all discrepancies and issues encountered during the period covered.

E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

F. Progress Reports.

G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

1. Submit to the Engineer within two weeks after completion of testing, adjusting, and balancing.

2. Revise TAB plan to reflect actual procedures and submit as part of final report.

3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.

4. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.

6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.

7. Units of Measure: Report data in I-P (inch-pound) units only.

8. Include the following on the title page of each report:

a. Name of Testing, Adjusting, and Balancing Agency.

b. Address of Testing, Adjusting, and Balancing Agency.

c. Telephone number of Testing, Adjusting, and Balancing Agency.

d. Project name.

e. Project location.

f. Project Architect.

g. Project Engineer.

h. Project Contractor.

i. Project altitude.

j. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

A. Perform total system balance in accordance with one of the following:

1. AABC MN-1, AABC National Standards for Total System Balance.

2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.

3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

4. SMACNA HVAC Systems Testing, Adjusting, and Balancing.

5. Maintain at least one copy of the standard to be used at project site at all times.

B. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.

2. Having minimum of two years documented experience.

3. Certified by one of the following agencies or methods:

a. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.

C. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

D. Acceptable TAB Agencies:

1. NEBB.

2. AABC.

3. SMACNA.

4. TABB.

5. Substitutions: Not permitted.

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.

2. Temperature control systems are installed complete and operable.

3. Proper thermal overload protection is in place for electrical equipment.

4. Final filters are clean and in place. If required, install temporary media in addition to final filters.

5. Duct systems are clean of debris.

6. Fans are rotating correctly.

7. Fire and volume dampers are in place and open.

8. Air coil fins are cleaned and combed.

9. Access doors are closed and duct end caps are in place.

10. Air outlets are installed and connected.

11. Duct system leakage is minimized.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions. Since work will occur in phases, provide listing of system deficiencies for systems to be balanced during the specified phases.

3.3 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.

1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

C. Provide additional balancing devices as required.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply and outside air systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:

1. Running log of events and issues.

2. Discrepancies, deficient or uncompleted work by others.

3. Contract interpretation requests.

4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

I. After all adjustments and corrections have been performed to balance system as designed, additional readjustment shall be performed to satisfy desired temperature.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities . Test and balance all air handlers for the three design positions i.e. minimum (5% adjustable) outside air, design outside air and economizer operation.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, barometric relief dampers, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

O. On fan powered VAV boxes, adjust air flow switches for proper operation.

P. Measure and record supply, return, outside and exhaust air cfm, fan rpm, motor amps, coil entering and leaving air, temperatures (both wet and dry bulb temperatures), outside air (wet and dry bulb temperatures) for cooling and heating operations, system static pressures shall be measured at the required conditions at the minimum and maximum fan speeds.

Q. Measure and record the following air handling and distribution systems.

1. Supply, return and outside air when CO2 sensor is above the setpoint and the outside air is set at scheduled design point. Measure and record heating and cooling coil(s) entering and leaving air temperatures (both wet and dry bulb) and outside air (both wet and dry bulb).

2. Supply, return, outside air and exhaust when system is in the economizer operation. Measure and record supply air and outside air temperatures (both wet and dry bulb).

3.7 SCOPE

A. Test, adjust, and balance the following:

1. Rooftop Unit
2. Humidifier.
3. Mini Split Units
4. Fans.
5. Air Filters.
6. Air Terminal Units.
7. Air Inlets and Outlets.

3.8 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

1. Manufacturer
2. Model/Frame
3. HP/BHP
4. Phase, voltage, amperage; nameplate, actual, no load
5. RPM
6. Service factor
7. Starter size, rating, heater elements

8. Sheave Make/Size/Bore

B. V-Belt Drives:

1. Identification/location
2. Required driven RPM
3. Driven sheave, diameter and RPM
4. Belt, size and quantity
5. Motor sheave diameter and RPM
6. Center to center distance, maximum, minimum, and actual

C. Heating Coils:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Entering air temperature, design and actual
7. Leaving air temperature, design and actual
8. Air pressure drop, design and actual

D. Return Air/Outside Air:

1. Identification/location
2. Design air flow
3. Actual air flow
4. Design return air flow
5. Actual return air flow
6. Design outside air flow
7. Actual outside air flow
8. Return air temperature

9. Outside air temperature
10. Required mixed air temperature
11. Actual mixed air temperature
12. Design outside/return air ratio
13. Actual outside/return air ratio

E. Exhaust Fans:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Air flow, specified and actual
6. Total static pressure (total external), specified and actual
7. Inlet pressure
8. Discharge pressure
9. Sheave Make/Size/Bore
10. Number of Belts/Make/Size
11. Fan RPM

F. Duct Traverses:

1. System zone/branch
2. Duct size
3. Area
4. Design velocity
5. Design air flow
6. Test velocity
7. Test air flow
8. Duct static pressure

9. Air temperature
10. Air correction factor

G. Terminal Unit Data:

1. Manufacturer
2. Type, constant, variable, single, dual duct
3. Identification/number
4. Location
5. Model number
6. Size
7. Minimum static pressure
8. Minimum design air flow
9. Maximum design air flow
10. Maximum actual air flow
11. Inlet static pressure

H. Air Distribution Tests:

1. Air terminal number
2. Room number/location
3. Terminal type
4. Terminal size
5. Area factor
6. Design velocity
7. Design air flow
8. Test (final) velocity
9. Test (final) air flow
10. Percent of design air flow

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Duct insulation.

B. Duct Liner.

C. Insulation jackets.

D. Adhesive, tie wires, tape

1.2 RELATED REQUIREMENTS

A. Section 23 01 00 - General HVAC Provisions.

B. Section 23 05 53 - Identification for HVAC Piping and Equipment.

C. Section 23 31 00 - Ducts: Glass fiber ducts.

1.3 REFERENCE STANDARDS

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

C. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).

E. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

I. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than five years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with a minimum five years of documented experience and approved by manufacturer.

C. Perform work at ambient and equivalent temperatures as recommended by the adhesive manufacturer. Work shall be performed only by mechanics who regularly perform this type of work only.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

B. Adhesives to be waterproof.

C. Recovering jackets 6 ounce per square yard canvas attached with a lagging fire retardant adhesive. Install on exposed ductwork insulation. Cover thoroughly with several coats of sizing.

2.2 GLASS FIBER, FLEXIBLE

A. Manufacturer:

1. Knauf Insulation.

2. Johns Manville Corporation.

3. Owens Corning Corp.

4. CertainTeed Corporation.

5. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Insulation: ASTM C553; flexible, noncombustible blanket.

1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.

2. Maximum Service Temperature: 450 degrees F.

3. Maximum Water Vapor Sorption: 5.0 percent by weight.

4. Maximum Moisture Absorption: 0.20 percent by volume.

C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.

2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E 96/E 96M.

3. Moisture Vapor Transmission: ASTM E 96; 0.02 perm.

4. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Outdoor Vapor Barrier Mastic:

1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

F. Tie Wire: Annealed steel, 16 gage.

2.3 GLASS FIBER, RIGID

A. Manufacturer:

1. Knauf Insulation.

2. Johns Manville Corporation.

3. Owens Corning Corp.

4. CertainTeed Corporation.

5. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Insulation: ASTM C612; rigid, noncombustible blanket.

1. 'K' value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.

2. Maximum service temperature: 450 degrees F.

3. Maximum Water Vapor Sorption: 5.0 percent.

4. Maximum Moisture Absorption: 0.20 percent by volume.

5. Maximum Density: 8.0 lb/cu ft.

6. Density: 3.0 lb/cu ft.

C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.

2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E 96/E 96M.

3. Moisture vapor transmission: ASTM E 96; 0.04 perm.

4. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Indoor Vapor Barrier Finish:

1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.

2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.4 JACKETS

A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

1. Lagging Adhesive:

a. Compatible with insulation.

B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.

C. Aluminum Jacket: ASTM B209 (ASTM B209M).

1. Thickness: 0.016 inch sheet.

2. Finish: Embossed.

3. Joining: Longitudinal slip joints and 2 inch laps.

4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.

5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.5 DUCT LINER

A. Manufacturers:

1. Knauf Insulation.

2. Johns Manville Corporation.

3. Owens Corning Corp.

4. CertainTeed Corporation.

5. Substitutions: See Section 23 01 00 - General HVAC Provisions. .

B. Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; semi-rigid duct liner; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.

1. Fungi Resistance: ASTM G21.

2. Substitutions: See Section 23 01 00 - General HVAC Provisions.

3. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.

4. Service Temperature: Up to 250 degrees F.

5. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.

6. Minimum Noise Reduction Coefficients:

a. 1/2 inch Thickness: 0.30.

b. 1 inch Thickness: 0.45.

c. 1-1/2 inches Thickness: 0.60.

d. 2 inch Thickness: 0.70.

C. Adhesive: Waterproof, fire-retardant type, ASTM C916.

D. Liner Fasteners: Galvanized steel, welded with press-on head.

2.6 MATERIALS

A. External Insulation

1. Concealed Round and Rectangular Ducts: Flexible glass fiber insulation, minimum installed R-value of R-6, with factory applied reinforced aluminum foil vapor barrier for systems conveying air at less than room temperature.

B. Internal Insulation

1. Rectangular Ducts and Plenums: Internal duct insulation shall be semi-rigid duct liner board manufactured from glass fibers bonded with a thermosetting resin. Insulation shall be coated on one side with a fire resistant black coating and shall have a minimum installed R-value of R-6. Duct liner shall be installed by cutting side pieces of insulation to lap both top and bottom sections for maximum support. Install side pieces first. Side pieces and bottom piece shall be attached with 4" strips of adhesive at one foot intervals. Top section of insulation shall be attached with Stick-Klip fasteners secured by Miracle adhesive spaced one fastener per two square feet of insulation. Edges of insulation shall be butted with adhesive to insure a tight joint and provide a smooth surface.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

C. Finish with system at ambient conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Insulated ducts conveying air below ambient temperature:

1. Provide insulation with vapor barrier jackets.

2. Finish with tape and vapor barrier jacket.

3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Insulated ducts conveying air above ambient temperature:

1. Provide with or without standard vapor barrier jacket.

2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces : Finish with canvas jacket sized for finish painting.

F. Duct and Plenum Liner Application:

1. Adhere insulation with adhesive for 100 percent coverage.

2. Secure insulation with welded mechanical liner fasteners. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible and NAIMA Fibrous Glass Duct Liner Standards (latest edition) for spacing.

3. Seal and smooth joints. Seal and coat transverse joints.

4. Seal liner surface penetrations with adhesive.

5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 SCHEDULES

A. Exhaust Ducts: Externally wrap.

B. Outside Air Intake Ducts:

1. Round: Externally insulate with 2-inch thick insulation, minimum installed R-value of R-6.

2. Rectangular: Internally insulate with 1-inch thick semi-rigid duct liner with adhesive and welded mechanical fasteners, minimum installed R-value of R-6.

C. Plenums: Internally insulate with 1-inch thick insulation, minimum installed R-value of R-6.

D. Concealed Supply Ducts:

1. Round Duct: Externally insulate with 2-inch thick insulation, minimum installed R-value of R-6.

2. Rectangular: Internally insulate with 1-inch thick, semi-rigid duct liner, minimum installed R-value of R-6, with adhesive and welded mechanical fasteners.

3. Spiral Duct (Lined): Internally insulate with 1-inch thick, semi-rigid duct liner between outer shell and lining. Refer to section 23 31 00 for spiral duct construction.

4. Spiral Duct (Unlined): Externally insulate with 2-inch thick insulation, minimum installed R-value of R-6.

E. Concealed Return Air Ducts and Plenums:

1. Round: Externally insulate with 2-inch thick insulation, minimum installed R-value of R-6.

2. Rectangular: Internally insulate with 1-inch thick, minimum installed R-value of R-6, semi-rigid duct liner with adhesive and welded mechanical fasteners.

3. Plenums: Internally insulate with 1-inch thick, minimum installed R-value of R-6, semi-rigid duct liner with adhesive and welded mechanical fasteners.

END OF SECTION

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 RELATED REQUIREMENTS

A. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCE STANDARDS

A. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

B. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

1.4 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than five years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of documented experience and approved by the manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with NFPA 255.

2.2 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

1. Armacell International.

2. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534 Grade 1; use molded tubular material wherever possible.

1. Minimum Service Temperature: -40 degrees F.

2. Maximum Service Temperature: 220 degrees F.

3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Exposed Piping: Locate insulation and cover seams in least visible locations.

D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

E. Inserts and Shields:

1. Application: Piping 1 inches diameter or larger.

2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

3. Insert location: Between support shield and piping and under the finish jacket.

4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

F. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 13.

G. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 SCHEDULE

A. Cooling Systems:

1. Condensate Drains from Cooling Coils: Flexible cellular insulation (interior drains only).

2. Refrigerant Suction: Flexible cellular insulation.

3. Refrigerant Hot Gas: Flexible cellular insulation.

END OF SECTION

SECTION 23 09 23

DDC CONTROLS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnish a complete system of temperature and ventilation controls in accordance with this specification section. Items of work included are as follows.

1. Provide all necessary hardware and software to meet the specified functional requirements as put forth in the specification and sequence of operation, as defined in Section 23 09 93 of this specification.

2. Prepare individual hardware layouts, interconnection drawings and control loop configuration data from project design data.

3. Implement the detailed design for all system input/output points, distributed control and system data bases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

4. Design all equipment cabinets, panels, and the data communication network cables including all associated hardware.

5. Provide and install all cabinets, panels, and data communication network cables including all associated hardware.

6. Provide and install all interconnecting cables between supplied cabinets, controllers, input devices and output devices.

7. Provide and install all interconnecting cables between all operator terminals and peripheral devices (such as printers, etc.) supplied under this section.

8. Provide complete specifications for all items supplied by others (such as printers, instruments, etc.).

9. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, start-up and commissioning.

10. Provide a comprehensive operator and technician training program as described herein.

11. Provide as-built documentation, software, and any control logic and all associated support documentation on approved media which accurately represents the final system.

B. Control equipment.

C. Software.

1.2 RELATED SECTIONS

A. Section 23 74 13 - Packaged Rooftop Air Conditioning.

B. Section 23 05 93 - Testing and Balancing.

C. Division 26 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005.

B. UL 916 - Underwriters Laboratories Standard for Energy Management Equipment

C. SBCCI - Southern Code Congress International

D. City, county, state, and federal regulations and codes in effect as of date of contract.

1.4 SYSTEM DESCRIPTION

A. General Requirements (BacNet)

1. A distributed logic control system complete with Direct Digital Control (DDC) and Direct Analog Control (DAC) software shall be provided. System shall be totally based on ANSI/ASHRAE Standard 135-1995, BACnet. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc. and all air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components.

2. The entire processing system shall be in complete compliance with the BACnet standard: ANSI/ASHRAE 135-1995. The system shall use BACnet protocols and LAN types throughout and exclusively. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

3. All logic controllers for terminal units, air handlers, central mechanical equipment, and Microsoft Windows-based operator's terminal(s) shall communicate and share data, utilizing only BACnet communication protocols.

4. All logic controllers shall be fully programmable. That is, programmable controllers for every terminal unit, air handler, all central plant equipment, and any other piece of controlled equipment shall be provided. Programming tools shall be provided as part of operator workstation for every controller supplied for the project.

B. General Requirements

1. Provide an engineered system of controls to accomplish the sequence of operations. This system is to control all specified equipment directly, without intervening conventional controls.

2. All Controllers for terminal units, air handlers, central mechanical equipment, and Windows based operators' terminal(s) shall communicate with each other and share information.

3. The controls contractor shall assume complete responsibility for the entire controls system as a single source and shall certify that he has on staff under his direct employ on a day to day basis, factory trained technical personnel, qualified to engineer, program, debug, and service all portions of the control system, including central system operators terminal, global controllers, terminal unit controllers, and all other portions of the control system.

C. Basic System Features:

1. Zone by zone control of space temperature, usage scheduling, optimum starting, equipment failure reporting, and override timers for off-hours usage. A zone is the area served by one HVAC unit .

2. Operator Terminal software shall be a Windows 98 or later application program. Software shall be multitasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Software shall completely support Windows 98 or Window NT Dynamic Data Exchange (DDE) interface. Software shall strictly follow Microsoft Windows API guidelines. Systems using proprietary software or Windows formats other than above are strictly prohibited. Operation of the terminal software shall be simple and intuitive.

3. Complete energy management firmware, including self adjusting optimum start, demand limiting, global control strategies and logging routines for use with total control systems. All energy management firmware shall be resident in field hardware and not dependent on the Operators Terminal for operation. Operators terminal software is to be used for access to field based energy management control firmware only.

4. Priority password security systems to prevent unauthorized use. Each user shall have an individual password. Each user shall be assigned which control functions they have access to.

5. Equipment monitoring and alarm function including information for diagnosing equipment problems.

6. The complete system including, but not limited to terminal unit controllers, Global controllers and Operator terminals shall Auto-restart, without operator intervention, on resumption of power after a power failure. Database stored in Global Controller memory shall be battery backed up for a minimum of 29 days. Unitary controllers shall utilize EEPROM for all variable data storage. Batteries on unitary controllers shall not be allowed.

7. Modular system design of proven reliability.

8. Each field panel capable of independent control.

9. All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the Operators Terminal.

10. Equipment runtime totalization of fans, heaters, boilers, etc., capable of alarm generation and alarm dial out to remote sites.

11. Room sensors with digital readout that allow the user to view room temperature, view outside air temperature, adjust the room setpoint within preset limits and set desired override time. User shall also be able to shut unit off from sensor.

12. Field control devices such as terminal unit controllers shall have optically isolated communication lines. Controllers not optically isolated and utilizing a ground referenced communication technique are specifically prohibited.

13. Communication wiring for field control devices shall not be dependent on daisy chaining of communication wiring. Communication wire may be run in star patterns, daisy chained or combination of either, allowing units to be added to a communication line easily in the future.

14. All hardware and software shall be designed and manufactured by U.S. corporations. All hardware shall be U.L. listed with integral labels showing rating.

1.5 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide data for each system component and software module.

C. Shop Drawings:

1. Within four weeks after award of contract, the supplier shall submit review drawings, installation and operation instruction and a recommended spare parts list.

2. Drawings shall be standard sizes (8.5 inches x 11 inches) or (11 inches x 17 inches).

3. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.

4. List connected data points, including connected control unit and input device.

5. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

6. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

7. Indicate description and sequence of operation of operating, user, and application software.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.

2. Include submittals data in final "Record Documents" form.

F. Operation and Maintenance Data:

1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.

2. Input/Output point and alarm point summary listing.

3. Electrical drawings showing all system internal and external connection points, terminal block layouts and terminal identification.

4. Manufacturer's instructions and drawings for installation, maintenance and operation of all purchased items.

5. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

6. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

7. Overall system operation and maintenance instructions, including preventive maintenance and troubleshooting instructions.

8. Complete recommended spare parts list.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

H. Provide ten (10) copies of submittal drawings.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Responsibility: The supplier of the system shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him.

C. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed at Design-Builder.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

E. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience approved by manufacturer with an office located within fifty (50) miles of constructions site.

F. Component Testing: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. Each and every controller, sensor, and all other components shall be individually tested by the manufacturer prior to shipment.

G. Tools, Testing and Calibration Equipment: Provide all tools, testing and calibration equipment necessary to ensure reliability and accuracy of the system.

H. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 PRE-CONSTRUCTION MEETING

A. Convene one week before starting work of this Section.

B. Require attendance of parties directly affecting the work of this Section.

1.8 WARRANTY

A. Warranty shall cover all costs for parts, labor, and associated travel, and expenses for a period of one year from completion of system demonstration.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the Vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.

C. This warranty shall apply equally to both hardware and software.

D. Correct defective Work within a five year period after Substantial Completion.

E. Provide one year manufacturer's warranty for field programmable micro-processor based units.

F. All warranties to begin at Date of Substantial Completion as accepted by the Owner.

1.9 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.

2. Limiting copying.

3. Preserving confidentiality.

4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Alerton Technologies.

B. Johnson Controls, Inc..

C. Trane, Inc.

D. KMC

E. Siemens

F. Alternative bidders will be accepted if prior to bid time they submit a complete proposal including submittal sheets, including AutoCad drawings of system proposed. Drawings shall be specific to project and include all information necessary to install system. Alternative bidders shall also submit a compliance statement that states paragraph by paragraph that their system meets or does not meet requirements of that paragraph. If the proposed system does not meet requirements of a specific paragraph, bidder's proposal shall explain paragraph by paragraph how proposed system does not meet requirement's of that specific paragraph.

2.2 OPERATOR STATION

A. Work Station:

1. Configuration: IBM-compatible pentium based microcomputer system or better.

2. Minimum memory: 32 Mb RAM.

3. Memory clock speed: 450 MHz.

4. Display: Super video color graphics adapter (SVGA), 17 inch non-interlaced color monitor, maximum 0.28 mm dot pitch.

5. Floppy disk drive: 1.44Mb.

6. Hard disk drive: 1 Gb or larger.

7. Mouse: Software supported mouse with support software including self building menus and displays of system operations and functions.

8. Modem: Internal type modem or proprietary data modem with cables and communication interfaces required to provide the specified functions, minimum 56.6 kbps rate.

9. Printer: Support color printer. Equal to Hewlett Packard 930 Series.

10. Operating System: Windows 98.

B. Displays

1. Operator Terminal shall display all data associated with project as called out on drawings and/or point list supplied. System shall be capable of displaying graphic file, text and dynamic point data together on each display. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated every second without any action by the user. Terminal shall allow user to change all field resident EMS functions associated with the project such as set points, time schedules, holiday schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to point addresses or other numeric/mnemonic indications.

2. All displays shall be generated and customized in such a manner by the local system supplier that they fit the project as specified. Canned displays shall not be acceptable. Displays shall use Standard English (or specified language) for labeling and readout. Systems requiring factory programming for displays or logic are specifically prohibited. All displays and programming shall be supported locally by the installing contractor without factory dependency or assistance.

3. Digital points shall be displayed as On/Off or with customized text. Text shall be justified Left, Right or Center as selected by the user. System must allow operator to change display assignment and also create new and original displays on line. System shall be supplied with a library of standard displays which may be used unaltered or be modified by the operator. Systems that do not allow customization or creation of new displays by the operator shall not be allowed.

4. Analog points shall be displayed with operator modifiable units. Analog Input points may also be displayed as individual objects on the display screen as an overlay to the system display. Analog Output points, when selected with the mouse, shall be displayed as a prompted dialog box. Selection for display type shall be individual for each point.

5. A Customized Menu Label shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu items may be mixed on the same display to allow sub displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A separate display security level may be assigned to each display and system point.

6. All dynamic point information shall be updated on the Operators terminal display once every 1 second. Any changes by the operator shall be acted on by devices in the field within 2 seconds maximum.

7. Displays may be modified on site or via remote communications.

8. System must have central controller to access system. System display to be at least 4 line X 20 character LED display.

9. Entire system shall operate without dependency on the central terminal.

C. Security System

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator terminal's functions unless user is logged on. This includes displays as outlined above.

2. Each Operators Terminal shall provide security for 20 users minimum. Each user shall have an individual password. Password shall be up to 4 alpha numeric characters, case sensitive. Each User shall be individually assigned which control functions and menu items the user has access to. All passwords, user names and access assignments shall be adjustable on-line, at the operators terminal. Each user shall also have a set security level that defines access to displays and also defines what individual points the user can control.

D. Display of Scheduling Information

1. Display of Weekly schedules shall show all information in easy to read 7 day (week) format for each schedule. This includes all on/off times for each day along with all optimum start information.

2. Holiday schedules shall show all dates that are to be holidays. Holidays shall be shown on the terminal in a graphical calendar format showing all scheduled days for a given month. User shall be able to easily scroll through the months for each year for up to 20 years into the future as a minimum. Each day assigned as a holiday shall display as "All Off" or show "Scheduled" for that day.

3. Event schedules shall be shown in the same graphical calendar format and manner as Holiday schedules. Event schedules allow for scheduling of special events up to 20 years into the future. After event has elapsed, control returns to normal schedule.

4. Operator shall be able to change all information for a given Weekly, Holiday or Event schedule if logged on with the appropriate security access. This includes all information that has to do with optimum start including assignments such as sensors to use and heating/cooling factors.

E. Alarm Indication

1. System Terminal shall provide visual and printed means of alarm indication. Printout of alarms shall be sent to the assigned terminal and port.

2. Provide log of alarm messages. Alarm log shall be archived to the hard disk of the system terminal. Each entry shall include point descriptor and address, time and date of alarm occurrence, point value at time of alarm, time and date of point return to normal condition, time and date of alarm acknowledge.

3. Alarm messages shall be in plain English (or specified language) and shall be user definable on site or via remote communication. System shall provide a minimum of 20 user definable messages for each zone controlled.

F. Trend Log Information

1. System shall periodically gather samples of point data stored in the field equipment and archive the information on the Operator terminals hard disk. Archive files shall be appended with new sample data, allowing samples to be accumulated over several years. Systems that write over archived data shall not be allowed. Samples may be viewed at the operators terminal in a Trend Log. Trend log displays shall be in spreadsheet format. Provide capability for operator to scroll through all trend log data. System shall automatically open archive files as needed to display archived data when operator scrolls through the data vertically. Display all trend log information in standard engineering units.

2. Operator shall be able to change trend log setup information as well. This includes information to be trend logged as well as interval at which information is to be logged. All points in the system may be logged. All operations shall be password protected.

3. Provide means for operator to export to a comma delimited file format all trend log data for use by other spread sheet programs. Operation of system shall not be affected by this operation. In other words, the system shall stay 100% on-line

G. Controller Status

1. Provide means for operator to view communication status of all controllers connected to the system. Display shall include controller, status and error count. Status will show if controller is communicating or not. Error count shall show actual count of communication errors between system and controllers in the field.

2. Provide means for operator to reset error count for all controllers to zero.

3. Provide capability to select alarm indication for each controller.

H. Configuration/Setup

1. Provide means for operator to display and change system configuration. This shall include but not be limited to system time, day of the week, date of day light savings set forward setback, printer type and port addresses, modem port and speed, etc. Items shall

be modified utilizing easy to understand terminology using simple mouse/cursor key movements.

2.3 GLOBAL CONTROLLER

A. General

1. Global controller shall provide battery backed real time clock functions. It shall also provide system communications to programmable and application specific controllers as noted in section 2.3 in the field. Global controller shall interface with Operator terminal(s) for information display. Global controllers shall share information in a Peer-to-Peer manner utilizing a high speed LAN communication network.

2. Global controller shall decide global strategies for system based on information from any points in the system regardless if the point is directly monitored by the controller. Program that implements these strategies shall be completely flexible and user definable. Any system utilizing factory pre-programmed global strategies that cannot be modified by field personnel on site or downloaded via remote communications are not acceptable. Changing global strategies via firmware changes is also unacceptable. Program executed speed shall be once per second as a minimum.

3. Programming shall be object oriented using control program blocks. Provide documentation in flow chart form for all programming as part of the final system As-Built documentation. Include samples of flow chart documentation in submittals. All flow charts shall be generated with CAD system and automatically downloaded to controller. No reentry of data base shall be necessary.

4. Provide means to view inputs and outputs to each program block in real time as program is executing. This function may be done via the Operators Terminal, field computer, or via modem.

5. Controller shall have a minimum of 1 Mb battery backed Static RAM, expandable to 4 Mb, along with 256 Kb of EPROM. Battery shall retain static RAM memory and clock functions for a minimum of 30 days. Battery shall be a field replaceable lithium type. Battery shall automatically re-charge on resumption of local power.

6. Communication to field devices shall be via four individual two wire communication trunks. Communication baud rate of each trunk shall be 9600 baud. All field devices shall automatically search and detect the communication rate to match the Global controller. All field devices on the communication trunk shall be optically isolated. Ground referenced communications to field devices is prohibited. Routing of communication trunk may be daisy chained, run in star patterns or any other configuration that makes wiring easiest. Global controller shall be capable of communication to all field controllers that manufacturer has made in the past to allow backward compatibility.

7. Controller shall have at a minimum, one (1) additional communication ports in addition to the LAN port. The port shall be RS-232, one for communication to portable field computer and one for a modem for remote communications. The other two ports shall be RS-485 for connection to a permanent panel mounted display device (see section 2.4 for description), and for future connection to other devices.

B. Remote Communications

1. Provide all functions that will allow remote communications via modem to off-site locations. Include modem along with all cabling necessary for installation.

2. Global Controller shall have capability to call out alarm conditions automatically if desired. Alarm message and site description shall be sent to off site computer or serial printer. If desired, controller may also send encoded message to digital pager. All Global controllers connected to the local LAN shall be capable of calling out alarm messages through one shared modem connected to one or more of the Global controllers on the local LAN.

3. Controller shall have capability to call 20 different phone numbers each as a minimum. Numbers called may be controlled by type of alarm, time schedule, holiday schedule or other selectable program parameters.

4. Owner shall provide standard voice grade phone line for remote communication function.

5. Global controller and supplied modem shall be capable of modem-to-modem baud rates of 14.4K baud minimum over standard voice grade phone lines. Lower baud rates shall be selectable for areas where local phone company conditions require lower baud rates.

C. Schedules

1. Schedules shall be arranged in a three tiered hierarchy as follows:

   a. Highest level: Event Schedules

   b. Middle level: Holiday Schedules

   c. Lowest level: Weekly Schedules

2. Each Global Controller shall have at a minimum:

   a. 100 Weekly time schedules (7 day)

   b. 100 Holiday schedules (400 programmable days each)

   c. 20 Event schedules (400 programmable days each) with 8 schedule entries per day

3. Each schedule may be assigned to any point, controller, or program in the system.

4. Each schedule (Weekly, Holiday and Event) shall be capable of performing an optimum start. Optimum start calculation shall be based on outside air temperature, zone air temperature deviation from zones daytime heating and cooling set points, and individual zone adaptive heating and cooling coefficients that are adjusted each day based on performance parameters of the individual zone. Each schedule may use identical or individual sensors in its calculations.

5. Holiday schedule shall be provided to allow operation of system based on different schedule on specified holidays. Display of Holiday schedule shall be via a monthly calendar format. Operator shall be able to scroll through months and years.

6. Event schedules shall be identical to Holiday schedule format. However, event schedule shall be a one time action that once that time period is passed, the event schedule shall be erased for that particular day. Events may be scheduled up to one year in advance.

7. Operator may define and setup all schedule information from system terminal, via portable computer on site or via remote communications. This includes all times, dates and optimum start parameters. These functions shall be password protected.

D. Logging Capabilities

1. Each Global Controller shall log as a minimum 150 user selectable points with a minimum of 100 samples per point with standard memory configuration. Logging shall be expandable, user defined, with additional memory in global controller. Sample time interval shall be from 1 to 1000 seconds. Sample initiation may be by any of the following conditions:

   a. Selectable begin and end date and time

   b. Point COS (Any system point)

   c. Point Alarm Status (Any system point)

   d. Schedule ON status (Weekly, Holiday or Event schedules)

2. Any point in the system whether it is real or calculated may be logged.

3. Logs may be viewed both on site or off-site via remote communication.

4. Global controller shall periodically upload trended data to Operator terminal for long term archiving if desired.

E. Alarm Generation

1. Alarms may be generated for any condition of the system. This includes things such as analog point high/low alarm limits, digital point COS, communication failure to terminal unit controllers, etc. Controller shall have a minimum of 6 alarm types with 7 categories for each type.

2. Each alarm may be dialed out as noted above.

3. Provide alarm log for viewing of alarms. Log may be viewed on site at the system terminal or off-site via remote communications.

F. Demand Limiting

1. System shall be capable of monitoring energy demand. Energy demand may be from any type of energy source such as electrical or gas. Provide a Demand Limiting routine which shall shed assigned points or zones in the system to prevent the demand from exceeding preset limits. Demand limiting routine shall be a priority shed type allowing automatic override of zone or point shed when assigned temperature sensor exceeds operator set limits. Routine shall be able to change between 4 sets of demand limit and restore set points based on time of day or operator command.

2. Zone shed method shall be by either preventing operation of heating and cooling, or by shifting the zones heating and cooling set points.

3. All parameters of the Demand Limiting routine shall be modifiable from the Operators Terminal or via remote communications.

G. Energy Logging

1. Each global controller shall provide for a minimum of 10 Energy Logs. Each log shall monitor an energy meter and record or calculate the following information for each Day, Month and Year:

   a. Energy consumption

   b. Demand peak value and time of peak

   c. Outside air temperature minimum, maximum and average value

   d. Heating and Cooling degree day calculation

2. Energy meter input may be from any type of energy source such as electric, BTU or gas. Input type shall be dry contact pulse for electric or gas meters.

H. Field Interface/Display Terminal

1. Provide interface capability to display terminals. Interface shall support up to 8 field terminals on each global controller. Field Terminal(s) shall connect to the Global controller via a two conductor RS-485 cable in a star or tee tap configuration allowing easy addition of terminals in the future.

2. Field Terminals shall be capable of displaying and commanding any and all points in the system including those points on other global controllers utilizing customizable menus and data displays. Field Terminal data displays shall be independent of Operator

Terminal displays. Field Terminal operation shall not be dependent on Operator terminal operation. See section 2.4 for field terminal description.

I. Memory Modules

1. Global Controller data storage memory shall be modular, allowing additional memory to be added in the field (two modules minimum). Additional memory may be allocated by the operator to increase the storage capability of any or all routines requiring memory for storage of data. Modules shall be battery backed static RAM in Single In-line Modules (SIMM) or other easily insertable package.

2.4 CONTROL UNITS

A. General

1. Provide programmable and application specific Terminal Unit Controller as needed to comply with sequence of operation, point list and drawings. All Terminal Unit Controller units shall be completely stand-alone with no loss of control if communication with global controller is interrupted. All control parameters, programs and local variables such as setpoint information shall be stored in EEPROM on board each Terminal Unit Controller allowing the operator to change information as desired. Controllers that utilize a battery to backup control parameters, etc., shall not be allowed.

2. Programmable Terminal Unit Controllers shall be used in custom applications such as central plant, built up air handlers, fume hoods or when application specific controllers sequence of operation is not applicable.

3. Communication from Global controller to Terminal Unit Controllers shall be via two wire communication trunk as specified for Global Controllers above. Any type of Terminal Unit Controller shall communicate on the same communication trunk. System shall communicate to one Terminal Unit Controller regardless of whether other Terminal Unit Controllers on the same communication line are powered and connected. Ground referenced communications is prohibited.

4. Global controller shall communicate to all field controllers manufacturer has made in the past as well as currently.

B. Programmable Terminal Unit Controllers

1. Each programmable Terminal Unit Controller shall be completely programmable from the system terminal, via field computer or via remote communications. Program execution rate shall be ten times per second minimum (once every 100 milliseconds).

2. This controller shall be programmed to perform custom strategies for system based on information from all points in the field. Program that implements these strategies shall be completely flexible and user definable. Any controllers utilizing factory programmed strategies that cannot be modified by field personnel on site, require factory assistance, or

cannot be downloaded via remote communications are not acceptable. Changing strategies via firmware changes is also unacceptable.

3. Programming shall be object oriented using program blocks familiar to control specialists for all program strategies. Provide documentation in flow chart form for all programming. Include samples of flow chart documentation in submittals. All flow charts shall be generated with CAD system and automatically downloaded to controller. No re-entry of data base shall be necessary. As-Built documentation of all software shall be provided to end user in flow chart form at completion of project.

4. Program and program parameters such as set points shall be stored in EEPROM. Battery backed RAM shall not be accepted for this level of controller.

5. All inputs shall be universal in that they accept analog and digital information. Inputs shall be capable of detecting a 0.1 second momentary closure. Analog inputs shall be capable of accepting thermistor inputs, 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA inputs. No external hardware shall need to be added for Terminal Unit Controller to accept these different types of inputs. All inputs shall utilize a minimum of 10 bit analog to digital conversion.

6. Every digital output shall have local status indication. Outputs shall have minimum control resolution of 0.1 seconds On or Off.

7. Each of the analog outputs shall be independently switch selectable to output 0 to 10 VDC or 4 to 20 mA. Unit shall be programmable to output a sub range of voltage or current to match the device controlled. Analog outputs shall use 8 bit digital to analog conversion.

8. Terminal Unit Controller may be programmed to control what is displayed on zone sensor display. See section 2.5. Terminal Unit Controller may be programmed to show alpha numeric values on zone sensor display in response to program changes or button presses on the zone sensor.

9. Each Terminal Unit Controller shall provide 24 VDC at 250 mA as a source of power for current transducer sensors in the field.

C. Application Specific Terminal Unit Controllers

1. Application Specific Terminal Unit Controllers shall be completely stand-alone controllers for unitary type controls such as VAV terminal boxes, heat pumps, AC units, unit ventilators, etc. All programs shall be resident in controller for complete stand-alone operation.

2. EEPROM technology shall be used for storage of program parameters such as set points, limits, etc., controllers utilizing a battery for backup of program parameters shall not be allowed.

3. All application specific Terminal Unit Controller units shall have capability to use Digital display zone sensor, or thermistor type zone sensor .

2.5 OPERATOR FIELD INTERFACE DEVICE

A. Hardware

1. Operator field interface shall communicate to global controller via RS-485 at 38.4K baud minimum. RS-232 port shall be available for reprogramming displays. This port shall be accessible without removing any covers from unit.

2. Provide minimum of 128K of nonvolatile RAM for display storage and 32K of EPROM. Battery shall retain memory for 30 days minimum.

3. Operator interface device shall be housed in plastic enclosure suitable for mounting in office area. Device shall be separate unit from global controller and mount on standard double wide box.

B. Displays

1. Operator Terminal shall display all data associated with project as called out on drawings and/or point list supplied. Information shall be labeled with English description on display and shall be shown in engineering units as labeled (i.e. temperature shall be displayed in degrees F, 72.3F.) Terminal shall allow user to change all EMS functions associated with the project such as set points, time schedules, holiday schedules, etc. with single button push. This shall be done without any reference to point addresses or other numeric/mnemonic indications.

2. All displays shall be generated and customized in such a manner by local system supplier that they fit the project as specified. No canned displays that are modifiable only by factory personnel shall be acceptable. Displays shall use Standard English for labeling and readout.

3. Menu system shall be used for display selection. Menu items on display shall allow penetration to lower level displays. Dynamic point information and menu items may be mixed on the same display to allow sub displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. Display security level may be assigned to each display.

4. All dynamic point information shall be updated every 1 second. Any changes by the operator shall be acted on by devices in the field within 1 second.

5. Cursor keys shall be used to move cursor to desired item for selection of new display or to allow the operator to make changes. Entry of name to view or change data shall not be necessary.

6. Displays may be modified on site or via remote communications.

C. Security System

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator terminal's functions unless user is logged on. This includes displays as outlined above.

2. Operator's Terminal shall access passwords from global controller that are user definable. Each password may have one of 10 security levels that define extent of access for operator once logged on with that password.

2.6 TEMPERATURE SENSORS

A. General

1. All temperature sensors to be solid state electronic, factory calibrated to within one-half degree F, totally interchangeable. Wall sensors to be housed in enclosure appropriate for application. Duct and well sensors to be electronically identical with housing appropriate for application. Provide appropriate wells for installation by others.

2. Provide Digital display zone sensors for all wall sensors as indicated on drawings.

B. Digital Display Zone Temperature Sensor

1. Sensor shall contain digital display and user function keys along with temperature sensor. Sensor shall function as occupant control unit. It shall allow occupant to raise and lower setpoint and activate terminal unit for night override use all within limits as programmed by building operator. Sensor shall also allow service technician access to terminal unit controller functions for use as system setup and test and service tool. Sensor shall display and allow modification of Terminal unit controller parameters such as VAV Minimum and Maximum CFM set points, Night heating and cooling set points, Minimum and Maximum setpoint limits. Systems that require a Hand held field service tool shall not be allowed.

2. Provide means for occupant to view room setpoint, room temperature and outside air temperature at each controller. Override time may be set and viewed in 0.1 hour increments. Override time count down shall be automatic, but may be reset to zero using function keys on unit. Display shall be blank in unoccupied mode unless a function button is pressed.

3. Display shall also be used for status and alarm indication as described in the sequence of operation.

2.7 OTHER SENSORS

A. Building Pressure Sensor:

1. Building pressure sensor shall be adjustable for both positive or negative area pressure and accurate to ± 5% of setting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the Owners Representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

D. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to insure a complete operating system in accordance with the sequences of operation and point schedules.

C. The controls contractor shall furnish and install all control components and necessary hardware, computing equipment, and software as defined in this specification.

D. Control wiring and terminations for the building automation system shall be provided by the controls contractor. In addition, all 24 VAC electrical work specified herein shall be the responsibility of the controls contractor. The controls contractor must accept responsibility for total system operation.

1. Wiring shall be installed in accordance with the requirements for low voltage controls as specified in the electrical specifications. Local codes shall have jurisdiction

E. All material and equipment used shall be standard components, regularly manufactured and available and not custom designed especially for this project. All systems and components, except site-specific software, shall have previously been thoroughly tested and proved in actual use prior to installation on this project.

F. The system architecture shall be fully modular, permitting expansion of application software, system peripherals, and field hardware.

G. The system, upon completion of installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

H. Locate and install components for easy accessibility; in general, mount 60 inches above floor with minimum 3'-0" clear access space in front of units. Obtain Owner Representative's

approval on locations prior to installation. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

I. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration and high temperatures.

J. Provide conduit and electrical wiring in accordance with Division 26. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

K. Identify all equipment and panels. Provide permanently mounted engraved tags to all panels.

3.3 INTERLOCKING AND CONTROL WIRING

A. Provide all 24 VAC interlock and control wiring. All wiring shall be installed in a neat and professional manner in accordance with Division 16 and all state and local electrical codes.

B. Provide all low voltage (24 VAC or below) wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions.

C. Low voltage control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the Owner's Representative prior to rough-in.

D. Low voltage communication wiring shall not be located within 6 feet of lighting ballast unless it is run inside conduit.

E. Provide auxiliary pilot duty relays on motor starters as required for control function.

F. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings; coordinate all high voltage (120 VAC and above) with electrical contractor.

G. All control wiring installed in mechanical, electrical, telephone and boiler rooms to be installed in conduit or raceways provided and installed by the control contractor. All other wiring to be installed in a neat and inconspicuous manner per local code requirements.

3.4 MANUFACTURER'S FIELD SERVICES

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.

C. Provide basic operator training for two (2) persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 24 hours dedicated instructor time. Provide training on site.

D. Provide the capability for off-site monitoring at Control Contractor's local and main office. At a minimum, off site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service.

E. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

B. Provide systems demonstration under provisions of Section 23 01 00.

C. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION

SECTION 23 09 93

HVAC SEQUENCE OF OPERATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.

B. Sequence of operation for:

1. Air terminal units.

2. Central fan systems.

3. Exhaust fans.

4. Variable volume air handling units (single zone) with economizer

1.2 RELATED SECTIONS

A. Section 23 09 23 - DDC Controls Systems.

B. Section 23 36 06 - Air Terminal Units - Variable Volune.

C. Division 26 - Electrical: Electrical characteristics and wiring connections.

1.3 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.

1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.

2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in the contract documents.

3. Include at least the following sequences:

a. Start-up.

b. Warm-up mode.

c. Normal operating mode.

d. Unoccupied mode.

e. Shutdown.

f. Capacity control sequences and equipment staging.

g. Temperature and pressure control, such as setbacks, setups, resets, etc.

h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.

i. Effects of power or equipment failure with all standby component functions.

j. Sequences for all alarms and emergency shut downs.

k. Seasonal operational differences and recommendations.

l. Interactions and interlocks with other systems.

4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.

6. Include schedules, if known.

C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.

1. Label with settings, adjustable range of control and limits.

2. Include written description of control sequence.

3. Include flow diagrams for each control system, graphically depicting control logic.

4. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.

5. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

6. Include all monitoring, control and virtual points specified in elsewhere.

7. Include a key to all abbreviations.

D. Points List: Submit list of all control points indicating at least the following for each point.

1. Name of controlled system.

2. Point abbreviation.

3. Point description; such as dry bulb temperature, airflow, etc.

4. Display unit.

5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.

6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.

7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.

8. Calculated point (Yes / No); i.e. a "virtual" point generated from calculations of other point values.

E. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1.4 QUALITY ASSURANCE

A. Design system under direct supervision of an experienced design professional in design of this Work and be a licensed contractor in the state of South Carolina.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 AIR TERMINAL UNITS

A. Single-duct Variable Volume:

1. Cooling with Reheat:

a. On a rise in space temperature above the cooling set-point, the unit modulates to its maximum airflow.

b. As the space temperature continues to fall to the heating set-point, the terminal modulates to its heating minimum airflow. At this point, the heat will be staged on as follows:

3.2 VAV BOX WITH REHEAT

A. Occupancy: The occupancy mode can be communicated or hardwired to the VAV via a binary input. Valid Occupancy modes for the VAV shall be:

1. Occupied: Normal operating mode for occupied spaces or daytime operation. When the unit is in the occupied mode the VAV shall maintain the space temperature at the active occupied heating or cooling setpoint. Applicable ventilation and airflow setpoints shall be enforced. The occupied mode shall be the default mode of the VAV.

2. Unoccupied: Normal operating mode for unoccupied spaces or nighttime operation. When the unit is in unoccupied mode the VAV shall maintain the space temperature at the stored unoccupied heating or cooling setpoint regardless of the presence of a hardwired or communicated setpoint. When the space temperature exceeds the active unoccupied setpoint the VAV shall modulate fully closed.

3. Occupied Bypass: Mode used to temporarily place the unit into the occupied operation. Tenants shall be able to override the unoccupied mode from the space sensor. The override shall last for a maximum of 4 hours (configurable). The tenants shall be able to cancel the override from the space sensor at any time. During the override the unit shall run in occupied mode.

B. Heat Cool Mode: The Heat Cool mode can be set by a communicated value or automatically by the VAV. In standalone or auto mode, the VAV shall compare the primary air temperature with the configured auto changeover setpoint to determine if the air is "hot" or "cold". Heating mode shall command the VAV to heat only; it implies the primary air temperature is hot. Cooling mode commands the VAV to cool only; it implies the primary air temperature is cold.

1. Heat Cool Setpoint: The space temperature setpoint shall be determined either by a local hardwired setpoint dial, the VAV default setpoint or a communicated value. The VAV uses the locally stored default setpoints when neither a local hardwired setpoint nor communicated setpoint is present. If both a hardwired setpoint and communicated setpoint exist, the VAV shall use the communicated value.

2. The occupied heating and cooling setpoints shall be limited by adjustable parameters in the VAV to prevent them from being set too low or too high. These limits do not apply in the unoccupied mode. In the Unoccupied mode the VAV shall always use the stored default (Unoccupied) setpoints. These setpoints shall be widened to accommodate night setback and shall be adjustable.

a. Setpoint: Heating Setpoint Low Limit; Default Value: 40°F.

b. Setpoint: Cooling Setpoint Low Limit; Default Value: 40°F.

c. Setpoint: Heating Setpoint High Limit; Default Value: 100°F.

d. Setpoint: Cooling Setpoint High Limit; Default Value: 110°F.

C. Cooling Operation: When the unit is in cooling mode, the VAV shall maintain the space temperature at the active cooling setpoint by modulating the airflow between the active cooling minimum airflow setpoint to the maximum cooling airflow setpoint. Based on the VAV occupancy mode, the active cooling setpoint shall be one of the following.

1. Occupied Cooling Setpoint; Default Value: 74°F.

2. Unoccupied Cooling Setpoint; Default Value: 85°F.

3. Occupied Min Cooling Airflow Setpoint; See VAV Schedule.

4. Occupied Max Cooling Airflow Setpoint; See VAV Schedule.

D. The VAV shall use the measured space temperature and the active cooling setpoint to determine the requested cooling capacity of the unit. The outputs shall be controlled based on the unit configuration and the requested cooling capacity.

E. Heating Operation: When the unit is in heating mode, the ASC shall maintain the space temperature at the active heating setpoint by modulating the airflow between the active heating minimum airflow setpoint to the maximum heating airflow setpoint. Based on the ASC occupancy mode, the active heating setpoint shall be one of the following:

1. Occupied Heating Setpoint; Default Value: 71°F.

2. Unoccupied Heating Setpoint; Default Value: 60°F.

3. Occupied Min Heating Airflow Setpoint; Default Value: See VAV Schedule.

4. Occupied Max Heating Airflow Setpoint; Default Value: See VAV Schedule.

F. The ASC shall use the measured space temperature and the active heating setpoint to determine the requested heating capacity of the unit. The outputs shall be controlled based on the unit configuration and the requested heating capacity.

G. Reheat Control: Reheat shall only be allowed when the primary air temperature is 5°F below the configured reheat enable setpoint, 70°F Operator configurable. The reheat will be enabled when the space temperature drops below the active cooling setpoint and the airflow is in the minimum cooling airflow setpoint. During reheat the VAV shall operate at its minimum heating airflow setpoint and energize the heat as follows:

1. Proportional Hot Water Reheat: Below heating setpoint modulate the hot water valve as required to maintain the active heating setpoint.

H. The Building Automation System (BAS) shall send the VAV the occupied space heating and cooling temperature setpoints. The BAS shall also send the following commands:

1. Occupied.

2. Unoccupied.

3. Heat/Cool Mode.

4. Priority Shutdown Commands.

I. If communication with the BAS is lost, the VAV shall use predetermined default setpoints and operate in the occupied mode.

J. Space Sensor Failure: If there is a fault with the operation of the zone sensor module, it shall be feed back to the BAS. Zone sensor failure shall cause the VAV to close and disable heat and Fan if available.

K. Reset: All diagnostics shall be capable of being reset through the zone sensor, service tool, BAS, or by cycling power to the unit.

L. The BAS system shall provide alarm messages for the following VAV diagnostics. The VAV shall initiate a failsafe operational sequence based on the diagnostic condition.

1. Discharge Air Temperature Failure: Manual reset required.

2. Low Air Flow: Manual Reset required.

3. Primary Air Temperature Failure: No Manual Reset required

4. Space Temperature Failure: Manual Reset required.

5. Local Setpoint Failure: No Manual Reset required

6. Flow Sensor Failure: No Manual Reset required.

M. Manual Output Test: The VAV shall be able to manually exercise all outputs for troubleshooting. This shall be done directly from the controller board with no need of additional tools.

N. Unit Identification: The VAV shall have the capability of flashing an LED upon receiving a command from a service tool or BAS. The VAV shall also be able to send the unit address to a service tool or BAS for unit identification from the controller board or space sensor with no need of additional tools.

O. Data Sharing: All VAVs shall be able to communicate in a peer-to-peer environment over a twisted pair of communications wire.

P. Master/Slave: Master/Slave shall be used for operating multiple units from a single space sensor. The Master unit shall share space temperature, setpoint, heat/cool mode, occupancy, fan operation, and capacity control algorithm data over a twisted pair of communication wire to ensure seamless cooperation between the units.

Q. VAV Air System Auto-Commissioning/Auto-Calibration

1. The building automation system shall provide the ability to automatically commission and calibrate the VAV Air System. The following tests shall be performed, at a minimum:

    a. Calibration of the air valve/damper.

    b. Verification of air flow through the VAV box.

    c. Verification of local reheat performance for hydronic reheat.

2. The building automation system (BAS) shall provide the ability to initiate the auto-commissioning/auto-calibration command directly from the user interface. Special service tools shall not be required.

3. The BAS shall provide the ability to stagger the auto-commissioning/auto-calibration sequence for groups of VAV boxes to allow the sequence to be performed during occupied hours, if necessary.

4. An auto-commissioning report for the VAV Air System shall be generated that contains the results of the auto-commissioning/auto-calibration tests. This report shall contain, at a minimum, the following information for each VAV box in the system:

    a. Name of VAV box.

    b. Date and time the VAV box was tested.

    c. Presence of any alarms.

    d. Space temperature and setpoint.

    e. Active airflow (in CFM).

    f. Air valve/damper position when the VAV box reaches 40% of the maximum cooling airflow setpoint.

    g. Air valve/damper position when the VAV box reaches 100% of the maximum cooling airflow setpoint.

    h. Discharge air temperature of the VAV box when the hydronic heat is active.

3.3 CENTRAL FAN SYSTEMS

3.4 EXHAUST FANS

A. Unless otherwise specified herein or on the drawings, restroom exhaust fans will be switched with lights. Electrical Contractor to have responsibility for interlocking the switching controls.

B. Service closet exhaust fans will be switched with lights. Electrical Contractor to have responsibility for interlocking the switching controls.

C. Electrical closet exhaust shall be controlled via a line voltage thermostat. Thermostat shall have override capability. Controls contractor shall have responsibility for interlocking electrical closet exhaust fan controls.

3.5 HUMIDIFIERS

A. When supply fan is running and air flow switch proves air flow, the system controller will use an input from a humidity sensor located in the occupied space to provide a proportional signal to the humidifier based upon the humidity requirement of the space. A high limit humidistat located at least 15 ft. from the dispersion tube in the supply air duct will disable the humidifier if the duct humidity reaches 85%.

3.6 PACKAGE UNIT

A. Occupied Operation:

1. Cooling mode: The RTU fan will energize. The three stages of DX cooling will stage on and off to maintain space cooling set point (adj.)

2. Economizer mode: If RTU is calling for cooling and outside air temperature is below 45 degrees F db (adj.), the outside air and return air dampers will modulate to maintain space cooling set point (Adj.). The maximum economizer damper opening shall be limited to fifty (50) percent of the total RTU supply cfm. As the space pressure rises, the normally open space outside air damper shall modulate closed to maintain space pressure set point.

3. Space ventilation mode: If RTU is running and the space CO2 sensor is above set point (adj.), then the outside air damper shall modulate open and remain open until CO2 set point is satisfied.

4. Heating mode: The RTU fan will be energized. The two stages of gas heat will stage on and off to maintain space heating set point (adj.).

B. Unoccupied Operation:

1. Cooling mode: The RTU fan shall operate the three stages of DX cooling and economizer to maintain space unoccupied cooling set point (adj.).

2. Heating mode: The RTU fan shall operate the heating stages to maintain space unoccupied heating set point (adj.).

3.7 GENERAL

A. Color graphics shall be created depicting each piece of equipment listed above and the control points shown on the control diagram and/or described in the sequence of operation.

B. Spaces served by AC-1 and AC-2 (Room F116) shall be monitored by the BAS for space temperature and shall initiate an alarm at the BAS front end.

END OF SECTION

SECTION 23 31 00

DUCTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

B. Spiral ductwork.

1.2 RELATED REQUIREMENTS

A. Section 23 07 13 - Duct Insulation: External insulation and duct liner.

B. Section 23 33 00 - Duct Accessories.

C. Section 23 33 30 - Air Duct Sealants.

D. Section 23 36 00 - Air Terminal Units.

E. Section 23 37 00 - Air Outlets and Inlets.

F. Section 23 05 93 - Testing, Adjusting, and Balancing.

1.3 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.

C. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

E. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).

F. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2015.

1.4 DEFINITIONS

A. Duct Sizes: Duct sizes indicated on drawings are inside clear dimensions.

B. Low Pressure: Static pressure in duct less than 1" WG and velocities less than 2000 fpm (10 meters/second).

C. Medium Pressure: Static pressure between 1 and 6 inches WG and velocities between 1500 and 3000 fpm.

1.5 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide data for duct materials, duct liner, and duct connections.

C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all systems.

D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

E. Confirm ductwork has been fabricated and installed in accordance with recommendations and SMACNA standards.

1.6 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

1.7 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A and NFPA 90B, standards.

1.8 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.

B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.

2. VOC Content: Not more than 250 g/L, excluding water.

3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.

4. For Use With Flexible Ducts: UL labeled.

5. Products:

a. Seal all joints and seams on sheet metal supply, return, makeup air and exhaust ductwork with "Hardcast" type DT sealing tape and type FTA adhesive or "Hardcast" iron grip 601 duct sealant installed in strict accordance with manufacturer's instructions. Clean all dirt, oil, moisture, etc., before applying adhesive. Duct tape, UL listed or not, is not acceptable.

b. Substitutions: See Section 23 01 00 - General HVAC Provisions.

C. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.

2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.

3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.

4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.

5. Other Types: As required.

2.2 DUCT ASSEMBLIES

A. All Ducts: Galvanized steel, unless otherwise indicated.

B. Low Pressure Supply (Heating Systems): 1 inch w.g. pressure class, galvanized steel.

C. Medium and High Pressure Supply: 3 inch w.g. pressure class, galvanized steel.

D. Return and Relief: 1 inch w.g. pressure class, galvanized steel.

E. General Exhaust: 1 inch w.g. pressure class, galvanized steel.

2.3 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE Handbook - Fundamentals.

C. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

D. Provide air foil turning vanes when rectangular elbows must be used.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

H. Lap metal duct in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

I. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide duct transition to louver area. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

J. Size round ducts installed in place of rectangular ducts from ASHRAE Table of Equivalent Rectangular and Round Ducts. No variation of duct configuration or sizes permitted except by written permission.

K. Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled.

2.4 FABRICATION FOR SPIRAL DUCTWORK

A. All concealed spiral ductwork within 60 feet of air handler shall be double wall construction and all concealed spiral ductwork beyond 60 feet of air handler shall be single wall with external insulation. Concealed spiral run outs to single VAV boxes within 60 feet of air handler shall be constructed of single wall spiral with external insulation. All exposed spiral ductwork shall be double wall with outer shell constructed of paint lock duct.

B. Double wall construction shall be comprised of an airtight, outer pressure shell, a 1 inch fiber glass insulation layer with protective membrane applied to the supply air side, and a perforated metal inner liner that completely covers the insulation throughout the system. All sizes listed are based on the inner liner diameter. Perforations are not to exceed 3/32 inch diameter. The percentage of open area shall be a minimum of 22 percent.

1. All insulated round duct through 58 inches shall be spiral lock seam duct with outer shell and inner liner manufactured from galvanized steel meeting ASTM A527-71.

2. All insulated round fittings shall be welded fittings with outer shell and inner liner manufactured of galvanized steel meeting ASTM Aa527-71. Outer shell shall match round straight duct outer shell.

3. The inner liners of both duct and fittings are to be adequately supported by metal spacers welded in position to maintain spacing and concentricity. An inner coupling shall be provided to align the inner liners of joining pieces to maintain good air flow conditions.

C. Single wall construction shall be comprised of an airtight, outer pressure shell. All sizes listed are based on the inner diameter. Insulate per Section 23 07 13.

1. All insulated round duct through 58 inches shall be spiral lock seam duct manufactured from galvanized steel meeting ASTM A527 71.

2. All insulated round fittings shall be welded fittings manufactured of galvanized steel meeting ASTM Aa527-71. Diameter shall match round straight duct diameter.

D. Outer shell surface, including grille taps, shall be prepared by pipe manufacturer for field painting.

E. Spiral pipe manufacturer shall provide acoustic adapters necessary to terminated duct ends.

F. Spiral pipe manufacturer shall factory install required supply grill taps as indicated on plans.

G. Spiral pipe manufacturer shall supply the required ring supports, couplings, reducers, etc. required for a complete system.

H. Acceptable spiral pipe manufacturers are:

1. United McGill Corporation.

2. Spiral Pipe of Texas (SPOT).

3. Duct Direct.

4. Substitutions: Refer to Section 23 01 00 - General HVAC Provisions.

I. Spiral pipe supplier shall provide a complete duct system layout, including fittings, to the Contractor for field installation verification.

2.5 MANUFACTURED DUCTWORK AND FITTINGS

A. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.

1. Insulation: Fiberglass insulation with aluminized fiberglass scrim vapor barrier film.

2. Pressure Rating: 6 inches WG positive and 1.0 inches WG negative.

3. Maximum Velocity: 5000 fpm.

4. Temperature Range: -10 degrees F to 160 degrees F.

5. R-6.0 Formaldehyde free insulation.

6. UL -181 (UL listed).

7. Manufacturers:

a. Hart & Cooley.

b. Flex Master.

c. Substitutions: See Section 23 01 00 - General HVAC Provisions.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. Flexible Ducts: Connect to metal ducts with draw bands.

E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

F. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

H. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

I. Use double nuts and lock washers on threaded rod supports.

J. Connect terminal units to supply ducts directly.

K. Connect diffusers or light troffer boots to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.

L. Connect flexible ducts to metal ducts per manufacturer's recommendations.

M. At exterior wall louvers, seal duct to louver frame .

N. Refer to HVAC plans for locations indicating double wall insulated spiral pipe and single wall externally insulated spiral pipe.

O. All round, rectangular, and spiral duct installed in exposed areas shall be paint lock duct.

3.2 CLEANING

A. Clean exterior of spiral duct in preparation for painting.

B. If determined by the Architect and/or Engineer, that during construction the duct systems were not adequately protected and dirt/debris was allowed to enter the installed ductwork, then it will be required by the HVAC contractor for the duct system to be cleaned. If required, clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

END OF SECTION

SECTION 23 33 00

DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air turning devices/extractors.

B. Backdraft dampers - metal.

C. Duct access doors.

D. Duct test holes.

E. Fire dampers.

F. Flexible duct connections.

G. Volume control dampers.

1.2 RELATED REQUIREMENTS

A. Section 23 31 00 - Ducts.

B. Section 23 36 06 - Air Terminal Units - Variable Volume.

C. Division 26 - Electrical: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

C. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

D. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

C. Project Record Drawings: Record actual locations of access doors and volume dampers.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Fusible Links: Two of each type and size.

1.5 QUALITY ASSURANCE

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

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Demonstrate resetting of fire dampers to authorities having jurisdiction and Owner's Representative.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:

1. Krueger.

2. PCI Industries, Inc; Pottorff Brand.

3. Ruskin Company.

4. Titus.

5. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

C. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with worm drive mechanism with removable key operator.

2.2 BACKDRAFT DAMPERS - METAL

A. Manufacturers:

1. Louvers & Dampers, Inc.

2. Nailor Industries Inc.

3. PCI Industries, Inc; Pottorff Brand.

4. Ruskin Company.

5. United Enertech.

6. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 DUCT ACCESS DOORS

A. Manufacturers:

1. Nailor Industries Inc.

2. Ruskin Company.

3. Greenheck Fan Corporation.

4. SEMCO Incorporated.

5. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.

1. Less Than 12 inches Square: Secure with sash locks.

2. Up to 18 inches Square: Provide two hinges and two sash locks.

3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.

4. Larger Sizes: Provide an additional hinge.

D. Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FIRE DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc.
2. Nailor Industries Inc.
3. Ruskin Company.
4. Greenheck Fan Corporation.
5. United Enertech.
6. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Ceiling Dampers: Galvanized steel, 22 gage frame and 16 gage flap, two layers 0.125 inch ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.

D. Horizontal Dampers: Galvanized steel, 22 gage frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

E. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

F. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide dynamic style dampers with stainless steel closure springs and latches for closure under air flow conditions. Configure with blades out of air stream.

G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.6 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Connector: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
    a. Net Fabric Width: Approximately 3 inches wide.
2. Metal: 3 inches wide, 24 gage thick galvanized steel.

2.7 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc.
2. Nailor Industries Inc.
3. Ruskin Company.
4. Greenheck Fan Company.
5. Jer-Air Manufacturing.
6. United Enertech.
7. Substitutions: See Section 23 01 00 - General HVAC Provisions.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

1. Fabricate for duct sizes up to 6 x 30 inch.
2. Blade: 24 gage, minimum.

D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

1. Blade: 18 gage, minimum.

E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

F. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on minimum 2-inch stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches provide regulator at both ends.

2.8 MISCELLANEOUS PRODUCTS

A. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.

1. Thickness: 2 mils.

2. High tack water based adhesive.

3. UV stable light blue color.

4. Elongation Before Break: 325 percent, minimum.

2.9 LOW VOLTAGE ELECTRO-BALANCE DAMPER

A. Provide a factory-mounted battery-operated damper drive to manually control dampers from a remote location. The damper drive shall have universal mounting capabilities to accommodate damper shafts ranging in size from 1/4 inch to 3/8 inch square and 1/4 inch to 1/2 inch round. The system shall consist of a battery powered damper drive pre-wired with plenum rated cable and female over-molded connector, wall or ceiling connector termination as indicated and handheld control module. Plastic surface termination plates shall be UL 94-10 flammability rated. The damper drive shall be operated by a handheld remote control module. The handheld remote control module shall include open circuit indicator, 2-color LED array damper position indicator and automatic motor shut-off feature at full open and full closed positions.

B. Dampers provided by others shall meet the following requirements.

1. Standoff bracket with minimum mounting surface of 3-1/2 inch x 4 inch for the drive unit.

2. 90 degree open-close motion.

3. Maximum torque to open/close 5 inch-lbs.

4. Standoff bracket mounting holes located to ensure that the worm gear axis is concentric with damper shaft axis.

2.10 REMOTE CONTROLLED VOLUME DAMPERS

A. Manufacturers

1. Roto Twist.

2. Young Regulator Company.

3. United Enertech.

4. Substitutions: Refer to Section 23 01 00 - General HVAC Provisions.

B. Furnish cable operated remote controlled volume dampers in branch ducts located in inaccessible ceilings and where indicated on the plans.

C. Provide ceiling cups for damper control adjustment flush with ceiling.

D. Damper shall be worm gear actuated via rotary cable.

E. Furnish additional factory cable retainer supports as required by the cable length. Mechanical Contractor shall be responsible for providing required cable lengths based upon actual field dimensions.

F. Ceiling cup, rotary cable and worm gear shall be furnished as one piece for installation with no linkage adjustment.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Demonstrate re-setting of fire dampers to Owner's representative.

G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

I. Provide balancing dampers on high velocity systems where indicated. Refer to Section 23 36 06 - Air Terminal Units.

END OF SECTION

SECTION 23 33 30

AIR DUCT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air duct sealants for permanently sealing fabricated joints and seams of HVAC air ducts and thermal insulation.

B. Reinforcing membrane for sealants.

1.2 RELATED SECTIONS

A. Section 23 07 13 - Duct Insulation.

B. Section 23 31 00 - Ducts.

C. Section 23 33 00 - Duct Accessories.

1.3 REFERENCES

A. ASTM D 1668 - Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing; 1995.

B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.

C. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.

D. UL 181A - Closure Systems for Use with Rigid Air Ducts and Air Connectors; Underwriters Laboratories Inc.; 2005.

E. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors; Underwriters Laboratories Inc.; 2005.

1.4 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Manufacturer's product data, including physical properties and application instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. Store materials in accordance with manufacturer's instructions. Protect from freezing.

1. Storage Temperature: 40 to 100 degrees F.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not apply below 35 degrees F. or above 120 degrees F.

B. Avoid high humidity.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

1. Hardcast, Inc.

2. RCD Corporation.

B. Substitutions: See Section 23 01 00 - General HVAC Provisions.

C. Supply all products specified in this section from a single manufacturer.

2.2 AIR DUCT SEALANTS

A. Low to High Velocity Air Duct Sealant: Non-toxic, water-based, fiber-reinforced adhesive-sealant; for permanently sealing fabricated joints and seams of sheet metal air ducts, UL 181 listed rigid fiberglass air ducts, UL 181 listed flexible air ducts, and thermal insulation; for repairing damaged and leaking air ducts; for sealing conditioned spaces from air infiltration.

1. Type: Elastomeric terpolymer emulsion.

2. Underwriters Laboratories Listed: UL 181A-M and UL 181B-M.

3. Solids by Weight: 67 percent, plus or minus 2 percent.

4. Weight per Gallon: 10.5 pounds, plus or minus 0.20 pounds.

5. Wet Film Coverage: 100 linear feet per gallon at 1/16 inch thick by 3 inches wide.

6. Consistency: Thixotropic, non-sagging.

7. Adhesive Cure: 72 hours at 50 percent humidity and 70 degrees F.

8. Service Temperature Limits: Minus 10 degrees to 180 degrees F.

9. Water Vapor Transmission Rate: 0.6157 perms in accordance with ASTM E 96.

10. Flame Spread Index: Not greater than 5, when tested in accordance with ASTM E 84.

11. Smoke Developed Index: Zero, when tested in accordance with ASTM E 84.

B. Low to High Velocity Air Duct Sealant: Hardcast Iron Grip 601 non-toxic, water-based, adhesive-sealant; for permanently sealing fabricated joints and seams of sheet metal air ducts, UL 181 listed rigid fiberglass air ducts, UL 181 listed flexible air ducts, and thermal insulation; for repairing damaged and leaking air ducts; for sealing conditioned spaces from air infiltration.

1. Type: Elastomeric terpolymer emulsion.
2. Underwriters Laboratories Listed: UL 181A-M and UL 181B-M.
3. Solids by Weight: 70 percent, plus or minus 2 percent.
4. Wet Film Coverage: 320 linear feet per gallon at 20 mil thick by 3 inches wide.
5. Consistency: Thixotropic, non-sagging.
6. Adhesive Cure: 48 hours at 50 percent humidity and 70 degrees F.
7. Flame Spread Index: Not greater than 5, when tested in accordance with UL-723.
8. Smoke Developed Index: Zero, when tested in accordance with UL-723.

C. Reinforcing Membrane: RCD "Glasscoat" inorganic woven fiberglass reinforcing membrane; conforming to irregular surfaces for sealing and coating thermal insulation, air ducts, return air plenums, equipment, vessels, pipes, and fittings.

1. ASTM D 1668, Type III.
2. Nominal Dry Weight: 1.2 to 2.0 ounces per square yard.
3. Saturated Weight: 1.6 to 2.6 ounces per square yard.
4. Nominal Thread Count: 10 by 20.
5. Breaking Strength, Saturated: 75 warp, 75 fill minimum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive air duct sealants.

B. Notify Architect of conditions that would adversely affect application of sealants. Do not proceed with application until unsatisfactory conditions are corrected.

3.2 SURFACE PREPARATION

A. Prepare surfaces in accordance with manufacturer's instructions.

B. Remove water, dirt, oil, grease, and corrosion from surfaces to receive air duct sealants.

3.3 APPLICATION

A. Apply air duct sealants in accordance with manufacturer's instructions.

B. Apply to sheet metal air ducts, UL 181 listed rigid fiberglass air ducts, UL 181 listed flexible air ducts, thermal insulation, and other surfaces where indicated.

C. Do not thin or mix.

D. Apply tack coat at rate of 2 gallons per 100 square feet.

E. Embed reinforcing membrane into tack coat.

F. Apply finish coat at rate of 2 gallons per 100 square feet.

G. Allow drying time as follows:

1. Minimum 6 hours when used outdoors if wet weather is imminent.

2. Minimum 24 hours before using air duct system.

3. Additional time as required by air temperature and humidity conditions.

END OF SECTION

SECTION 23 34 23

POWER VENTILATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Roof exhausters.

1.2 RELATED REQUIREMENTS

A. Section 23 31 00 - Ducts.

B. Section 23 33 00 - Duct Accessories: Backdraft dampers.

C. Division 26 - Electrical: Equipment Wiring.

1.3 REFERENCE STANDARDS

A. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

B. AMCA 261 - Directory of Products Licensed to Use the AMCA Certified Ratings Seal; Air Movement and Control Association International, Inc.; http://www.amca.org/licenses/search.aspx.

C. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

D. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

E. NEMA MG 00001 - Motors and Generators; 2024.

1.4 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Indicate installation instructions.

D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.5 QUALITY ASSURANCE

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

B. Equivalent fan selections shall not increase or decrease motor horsepower, increase top speed by more than 10%, or increase inlet air velocity by more than 20% from that specified.

C. Provide fans capable of accommodating static pressure variations of plus or minus 10%.

D. Provide balanced variable for motors 15 horsepower and under.

E. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas of the building.

F. Provide belt guards on belt driven fans.

G. Provide safety screen where inlet or outlet is exposed.

H. Prime coat fan wheels and housing factory inside and outside. Prime coating on aluminum parts is not required.

1.6 FIELD CONDITIONS

A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acme.

B. Captive Aire.

C. Greenheck.

D. Loren Cook Company.

E. Twin Cities Blower.

F. Substitutions: See Section 23 01 00 - General HVAC Provisions.

2.2 POWER VENTILATORS - GENERAL

A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.

C. Fabrication: Conform to AMCA 99.

D. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.3 ROOF EXHAUSTERS

A. Performance Ratings:

1. Refer to fan schedule on plan sheet for fan performance.

B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

C. Roof Curb: 14 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and solid state speed controller.

E. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.

F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Provide sheaves required for final air balance.

D. Install backdraft dampers on inlet to roof exhausters.

3.2 SCHEDULES

A. Drawing Code: See plan Schedule.

B. Air Flow Capacity: See plan Schedule.

C. Static Pressure: See plan Schedule.

D. Motor hp:

1. Electrical Characteristics: See plan Schedule.

E. Accessories:

1. See plan Schedule.

END OF SECTION

SECTION 23 36 06

AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single Duct Terminal.

1.2 RELATED REQUIREMENTS

A. Furnish and install TITUS Model (P)(A)(D) ESV single duct, variable air volume terminals of the sizes and capacities shown in the plans.

B. Terminals shall be certified under the ARI Standard 880 Certification Program and carry the ARI Seal. Noncertified terminals may be submitted after testing at an independent testing laboratory under conditions selected by the engineering consultant in full compliance with ARI Standard 880. These tests must be witnessed by the engineering consultant with all costs to be borne by the terminal manufacturer. Testing does not ensure acceptance.

1.3 SUBMITTALS

A. Submit shop drawings and product data sheets indicating configuration, general assembly, and materials used in fabrication.

B. Submit product performance data indicating design air flow, minimum static pressure drop, fan operating condition.

C. Submit installation, operation and maintenance documentation.

D. Submit sound power and noise criteria (NC) values for radiated and discharge paths.

1.4 QUALIFICATIONS

A. Manufacturer: The company manufacturing the products specified in this section shall have a minimum of ten years experience producing products of this type.

1.5 SYSTEM RESPONSIBILITY

A. The contractor shall be responsible for any and all costs associated with any and all changes resulting from the use of a supplier other than the listed acceptable manufacturers.

B. The duct system is computer designed for air balance and noise control using the performance data of the listed manufacturer. Substituting another VAV terminal unit manufacturer may require changes in the system design. These changes may include, but are not limited to, changes in ductwork size or layout, fittings, controls, building structure and piping.

1.6 WARRANTY

A. Provide manufacturer's parts warranty for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Daikin.

B. Titus.

C. Trane Inc.

D. Price.

E. Metal Aire.

F. JCI.

G. Substitutions: See Section 23 01 00 - General HVAC Provisions.

2.2 GENERAL

A. The terminal casing shall be minimum 22-gauge galvanized steel, internally lined with engineered polymer foam insulation which complies to UL181 and NFPA 90A. Insulation shall be 1½ pound density, closed cell foam. Exposed fiberglass is not acceptable. The insulation shall be mechanically fastened to the unit casing. The casing shall be constructed to hold leakage to the maximum values shown in the Casing Leakage table.

B. The damper shall be heavy gauge steel with shaft rotating in Delrin® self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage to the maximum values shown in the Damper Leakage table.

1. Actuators shall be capable of supplying at least 35-inch lbs. of torque to the damper shaft and shall be mounted externally for service access. Terminals with internal actuator mounting or linkage connection must include gasketed access panel, removable without disturbing ductwork. Casing with access panel shall be constructed to hold leakage to the maximum values shown in the Casing Leakage table.

C. At an inlet velocity of 2000 fpm, the minumum static pressure required to operate any terminal size shall not exceed 0.13-inch wg for the basic terminal.

D. Sound ratings for the terminal shall not exceed noise criteria at static pressure. Sound performance shall be ARI certified.

2.3 ELECTRIC REHEAT COIL

A. Electric coils shall be supplied and installed on the terminal by the terminal manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5 inches to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3.5 inches apart, staggered for maximum thermal transfer and element life and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety devices.

B. Electric coils shall contain a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, differential pressure airflow switch for proof of flow, and line terminal block. Unit shall include an optional integral door interlock type disconnect switch that will not allow the access door to be opened while power is on. Non-interlocking type disconnects are not acceptable. All individual components shall be UL listed or recognized

C. Electric coils shall include line fusing, mercury contactors mounted and wired within the control enclosure.

2.4 WIRING

A. Factory install and wire power line fusing, a disconnect switch and a 24 VAC transformer for control voltage (and power). Provide terminal strip in control box for field wiring of power source.

B. Factory install and wire all terminal unit fan controls. Install electrical components in control box with removable cover. Incorporate single point electrical connection to power source.

C. Disconnect Switch: Provide single and dual duct terminals with a factory installed and wired switch to disconnect power to the unit controls.

D. Power Line Fuse: Provide terminal units with integral power line fusing installed in the control box to prevent overcurrent damage to the unit controls.

E. Control Transformer: Provide terminal units with a factory installed and wired 24 VAC transformer to provide control voltage power to the unit.

2.5 DIRECT DIGITAL VAV CONTROLS

A. Direct Digital Controls

1. General. Direct digital controls (DDC) and factory costs to mount, calibrate and test the system shall be the responsibility of Section 23 09 24 DDC Controls Systems/Building Automation System (BAS) Contractor.

2. Multi-point, multi-axis flow ring or cross sensor to be furnished and mounted by terminal unit manufacturer. Single point or flow bar sensors are not acceptable. Flow sensing

device shall be capable of maintaining airflow to within +/- 5 percent of rated unit airflow setpoint when installed with 1.5 duct diameters straight duct, of the same size as the primary airflow inlet, upstream from the unit.

B. Variable Air Volume (VAV) Terminal Unit Control

1. The VAV terminal units shall be individually controlled by a DDC VAV controller per VAV terminal unit. The DDC VAV controller, damper motor, and transducer shall be supplied and installed by the BAS contractor.

2.6 TESTING/VERIFICATION

A. Factory set and test all analog electronic controllers to within 5% of the scheduled maximum and minimum settings. Base performance on test in accordance with ARI880.

B. Maximum Casing Leakage: 1 percent of nominal air flow at 0.5 in wg inlet static pressure.

C. Maximum Damper Leakage: 1 percent of design air flow at 4 in wg inlet static pressure.

2.7 PART 3 EXECUTION

2.8 INSTALLATION

A. Install in accordance with manufacturer's instructions.

2.9 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation form 100 percent of design air flow to 25 percent nominal air flow for cooling units and 30 to 50 percent for units with heating coils.

2.10

END OF SECTION

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Laminair Flow Diffusers.

B. Diffusers.

C. Slot ceiling diffusers.

D. Registers/grilles.

1. Ceiling-mounted, egg crate exhaust and return register/grilles.

2. Wall-mounted, exhaust and return register/grilles.

E. Louvers.

1.2 REFERENCE STANDARDS

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2023.

B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets; 2023.

C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

1.3 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Project Record Documents: Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.

B. Test and rate louver performance in accordance with AMCA 500-L.

1.5 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Air Devices, Inc.

B. Carnes Company HVAC.

C. Krueger.

D. Nailor.

E. Price Industries.

F. Ruskin.

G. Titus.

H. Tuttle-Bailey.

I. Substitutions: See Section 23 01 00 - General HVAC Provisions.

2.2 LAMINAR FLOW DIFFUSERS

A. Type: Provide low velocity, unidirectional airflow pattern..

B. Frame: Surface mount, inverted T-Bar type. In plaster ceilings, provide plaster frame and ceiling frame.

C. Fabrication: Steel or aluminum as indicated on drawings with baked enamel finish.

D. Color: As shown on drawings.

E. See Air Distribution Schedule on drawings for details and accessories.

2.3 SQUARE CEILING DIFFUSERS

A. Type: Provide high performance 3-cone diffuser diffuser to discharge air in 360 degree pattern .

B. Frame: Surface mount, inverted T-Bar type. In plaster ceilings, provide plaster frame and ceiling frame.

C. Fabrication: Steel or aluminum as indicated on drawings with baked enamel finish.

D. Color: As shown on drawings.

E. See Air Distribution Schedule on drawings for details and accessories.

2.4 CEILING RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, horizontal face.

B. Frame: Surface mount, inverted T-Bar type. In plaster ceilings, provide plaster frame and ceiling frame.

C. Fabrication: Steel or aluminum as indicated on drawings with baked enamel finish.

D. Color: As shown on the drawings.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans, where indicated on plans.

F. See Air Distribution Schedule on drawings for details and accessories.

2.5 CEILING GRID CORE EXHAUST REGISTERS/GRILLES

A. Type: Fixed grilles of 1/2 x 1/2 x 1/2 inch louvers.

B. Fabrication: Aluminum with factory baked enamel finish.

C. Frame: Surface mount, inverted T-Bar type. In plaster ceilings, provide plaster frame and ceiling frame.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face, where indicated on plans.

E. See Air Distribution Schedule on drawings for details and accessories.

2.6 CEILING SLOT DIFFUSERS

A. Type: Continuous 1 inch wide slot, two slots indicated on plans, with adjustable vanes for left, right, or vertical discharge .

B. Fabrication: Aluminum extrusions or steel as indicated on drawings with factory baked enamel finish.

C. Color: As shown on the drawings.

D. Frame: 1-1/4 inch margin with support clips for T bar mounting and gasket, mitered end border.

E. Plenum: Integral, galvanized steel, insulated.

2.7 WALL RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, horizontal face.

B. Frame: 1-1/4 inch margin with countersunk screw mounting.

C. Fabrication: Steel or aluminum as indicated on drawings with factory baked enamel finish.

D. Color: As shown on the drawings.

E. See Air Distribution Schedule for details and accessories.

F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face, where indicated on plans.

2.8 LOUVERS

A. Type: 6 inch deep with blades on 45 degree slope , heavy channel frame, 1/4 inch square mesh screen over exhaust and 1/4 inch square mesh screen over intake.

B. Type: Combination louver/dampers, drainable type with drain gutters in each blade and downspouts in jambs and mullions. 6 inch deep with blades on 37 degree slope. 1/4 inch square mesh screen over exhaust and 1/4 inch square mesh screen over intake.

C. Color: As shown on the drawings.

D. Fabrication: 12 gage thick extruded aluminum, welded assembly, with finish as indicated on Air Distribution Schedule.

E. Mounting: Furnish with standard frame and extended sill for installation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black.

F. Provide minimum 6" deep plenum box on back of all return and exhaust grilles.

3.2 SCHEDULES

A. Air Outlet and Inlet Schedule

1. Manufacturer: As scheduled on drawings.

2. Model: As scheduled on drawings.

3. Description: As scheduled on drawings.

4. Finish: As scheduled on drawings.

5. Mounting: As scheduled on drawings.

6. Accessories: As scheduled on drawings.

END OF SECTION

SECTION 23 40 00

AIR CLEANING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Disposable, extended area panel filters.

1.2 RELATED REQUIREMENTS

A. Division 26 - Electrical: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. AHRI 850 (I-P) - Performance Rating of Commercial and Industrial Air Filter Equipment; 2013 (Reaffirmed 2023).

B. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

C. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2017, with Addendum (2022).

1.4 PERFORMANCE REQUIREMENTS

A. Conform to 1 Section 7.4.

1. Dust Spot Efficiency: Plus or minus 5 percent.

1.5 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions and connection requirements.

C. Shop Drawings: Indicate filter assembly and filter frames, dimensions and connection requirements.

D. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.

E. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Filters: One additional set of each type and size of disposable panel filters to be installed at the time the building is conveyed to the Owner.

PART 2 PRODUCTS

2.1 FILTER MANUFACTURERS

A. American Filtration Inc.

B. AAF International/American Air Filter.

C. Camfil Farr Company.

D. Substitutions: See Section 23 01 00 - General HVAC Provisions.

2.2 DISPOSABLE, EXTENDED AREA PANEL FILTERS

A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton and synthetic fabric; supported and bonded to welded wire grid .

1. Frame: Cardboard.

2. Nominal size: to match equipment filter size requirements.

3. Nominal thickness: 2 inches.

B. Rating, per ASHRAE Std 52.1:

1. Dust spot efficiency: MERV 8.

2. Initial resistance at 500 FPM face velocity: 0.30 inch WG.

3. Recommended final resistance: 0.9 inch WG.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install air cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

3.2 SCHEDULES

A. Air Filter Schedule

1. Refer to plan Equipment Schedule.

END OF SECTION

SECTION 23 55 33

ELECTRIC WALL HEATERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electric unit heaters.

1.2 RELATED REQUIREMENTS

A. Division 26 - Electrical.

1.3 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2002.

B. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2006.

C. UL - Underwriters Laboratories Inc.

1.4 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.

D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.5 QUALITY ASSURANCE

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

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 WARRANTY

A. All warranties to begin at Date of Substantial Completion as accepted by the Owner.

PART 2 PRODUCTS

2.1 UNIT HEATER MANUFACTURERS

A. Modine Manufacturing Company.

B. Sterling HVAC/Mestek Technology, Inc.

C. Reznor/Thomas & Betts Corporation.

D. Markel.

E. Trane.

F. Indeeco.

G. Substitutions: See Section 23 01 00 - General HVAC Provisions.

2.2 ELECTRIC UNIT HEATERS

A. Contractor shall supply and install heavy duty wall mounted forced air electric heaters of the wattage, voltage and phase as specified on the drawings. The heater shall so be designed to provide an even distribution of heated air to the space to be heated by drawing return air in the peripheral area of the heater across and through the element which shall then be discharged from the center section of the heater by means of an electric motor and axial flow fan blade

B. Heaters shall be surface mounted to extend no more than 5 3/4" from the finished wall.

C. Heater front shall withstand 10.8 ft. lbs. (324 poundals) impact and 400 lbs. static force applied to an 8 sq. in. area at center grille location with less than 1/16" permanent distortion. The combination return and supply grille assembly shall be constructed of 1/16" x 3/8" rounded edge horizontal steel louvers which shall be spaced for maximum opening of 1/4". Louvers shall be welded at every intersection to three evenly spaced 1/16" diameter vertical members and completely framed in a heavy gauge natural anodized Aluminum extrusion. Front assembly shall be attached to the chassis by hidden tamper-resistant (Allen-head) machine screws. All other parts shall be 16 Gauge steel Zinc coated, both sides finished in a high gloss or bronze colored baked powder coat finish.

D. Motor shall be a permanently lubricated unit bearing, totally enclosed shaded pole type with impedance protection. Motors shall operate at no more than 1400 RPM and shall be same voltage as the heater. A protective shield shall surround the motor to separate return air from heated air.

E. Heater shall have a rating as indicated on the drawings.

F. Element assemblies shall consist of two or three corrosion resistant steel sheathed type elements mechanically bonded to common corrosion resistant steel fins. Each sheathed element shall consist of helically coiled Nickel Chromium alloy resistant wire completely embedded in and surrounded by Magnesium Oxide, enclosed and wedged into corrosion resistant steel sheaths. Elements shall have 2" cold conductor pins extending into the sheath and shall have a density of no more than 60 Watts per inch.

G. Heaters shall be equipped with a "manual reset" thermal overload which disconnects elements and motor in the event normal operating temperatures are exceeded. For safety, if opened due to abnormal temperature, thermal overload shall remain open until manually reset. Automatic reset thermal overloads which allow the element to continue to cycle under abnormal conditions will not be accepted.

H. Heaters shall be ETL Listed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that space is ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with NFPA 90A and NFPA 90B.

B. Provide vent connections in accordance with NFPA 211.

C. Provide connection to electrical power systems.

3.3 SCHEDULES

A. Electrical Unit Heaters

1. Refer to plan Schedule.

END OF SECTION

SECTION 23 74 13

PACKAGED ROOFTOP UNITS

PART 1 - GENERAL

1.1

A. Packaged Rooftop units.

1.2 GENERAL DESCRIPTION

A. This section includes the design, controls and installation requirements for packaged rooftop units/heat pumps/outdoor air handling units.

1.3 QUALITY ASSURANCE

A. Packaged air-cooled condenser units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.

B. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

C. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

D. Unit shall be certified in accordance with ANSI Z21.47b/CSA 2.3b and ANSI Z83.8/CSA 2.6, Safety Standard Gas-Fired Furnaces.

E. Unit Seasonal Energy Efficiency Ratio (SEER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

F. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.4 SUBMITTALS

A. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories,electrical characteristics and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.

B. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submittedwith specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be shipped with doors bolted shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.

B. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

1.6 WARRANTY

A. Manufacturer shall provide a limited “parts only” warranty for a period of 24 months from the date of original equipment shipment from the factory. Warranty shall cover material and workmanship that prove defective,within the specified warranty period, provided manufacturer’s written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and air filters.

1.7 STARTUP REPAIR PROGRAM

A. Manufacturer shall provide startup repair for a period of 12 months from the date of original equipment shipment from the factory. Program shall cover labor for materials and workmanship that prove defective,within the specified warranty period, provided manufacturer’s written instructions for installation, operation and maintenance have been followed. Program excludes labor associated with routine maintenance, such as belt and air filter replacement.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers:

1. AAON

2. Daikin Rebel.

3. Substitutions: See Section 23 01 00 - General HVAC Provisions.

2.2 ROOFTOP UNITS

A. General Description

1. Packaged rooftop unit shall include compressor, evaporator coil, filters, supply fan, dampers,air-cooled condenser coils, condenser fan,reheat coil,gas heater,and unit controls.

2. Unit shall be factory assembled and tested includingleak 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.

3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.

4. Unit components shall be labeled, includingrefrigeration system components andelectrical and controls components.

5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.

6. Installation, Operation and Maintenance manual shall be supplied within the unit.

7. 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.

8. 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.

2.3 CONSTRUCTION

A. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.

B. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.

C. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation,provides a cleanable interior, reduces heat transfer through the panel, and prevents exterior condensation on the panel.

D. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 210/240.Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width.Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

E. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.

F. Access to filters, dampers,cooling coil,reheat coil,heater,compressor,and electrical and controls components shall be through hinged access doors with quarter turn, lockable handles. Full length stainless steel piano hinges shall be included on the doors.

G. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

H. Units shall include double sloped 304 stainless steel drain pans.

I. Unit shall be provided with through the base vertical discharge and return air openings. All openings through the unit shall have upturned flanges of at least 1/2 inch around the opening.

J. Unit shall include lifting lugs on the top of the unit.

2.4 ELECTRICAL

A. Unit shall have a 5kAIC SCCR.

B. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.

C. Unit shall be provided with a factory installed and field wired 115V, 20 amp GFI outlet in the unit control panel.

2.5 SUPPLY FANS

A. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.

B. Blowers and motors shall be dynamically balanced.

C. Motor shall be inverter rated efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

D. Variable frequency drive shall be factory wired and mounted in the unit. Fan motor shall be inverter rated efficiency.

E. Cooling Coils

F. Evaporator Coils

1. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

2. Coil shall be 6 row high capacity

3. Coils shall be helium hydrogen or helium leak tested.

4. Coils shall be furnished with factory installed thermostatic expansion valves.

2.6 REFRIGERATION SYSTEM

A. Unit shall be factory charged with R-454B refrigerant.

B. 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.

C. 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.

D. 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.

E. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.

F. 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 pressureand low pressure sides and a factory installed liquid line filter driers.

G. Unit shall include a variable capacity scroll compressor on the refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.

H. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation,which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

I. The factory installed controls shall include a 3 minute off delay timer to prevent compressor short cycling and an adjustable compressor lockout.

2.7 CONDENSERS

A. Air-Cooled Condenser

1. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.

2. Coils shall be designed for use with R-454B refrigerant.

3. Condenser coils shall be multi-pass and fabricated from aluminum microchannel tubes.

4. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.

5. Coils shall be hydrogen or helium leak tested.

6. Condenser fans shall be high efficiency electrically 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 35°F with adjustable compressor lockout.

2.8 GAS HEATING

A. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.

B. 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.

C. 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.

D. Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.

E. High Turndown 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 compartment. Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet. Heat trace shall be include on the condensate drain

2.9 FILTERS

A. Unit shall include 2 inch thick, fiberglass throwaway filters with an ASHRAE MERV 8, upstream of the cooling coil.

B. Unit shall include 1 inch aluminum mesh pre filters upstream of the outside air opening.

C. Unit shall include a clogged filter switch.

2.10 OUTSIDE AIR/ECONOMIZER

A. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals.Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper.Unit shall include outside air opening bird screen, outside air hood with rain lip and barometric relief dampers.

B. Damper assembly shall be controlled by spring return enthalpy activated fully modulating actuator.

C. Controls

D. Factory Installed and Factory Provided Controller

1. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.

2. Controller shall be capable of stand alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.

3. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

4. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.

5. Variable Air Volume Controller

a. Unit shall utilize a variable capacity compressor system and a variable speed supply fan system to modulate cooling and airflow as required to meet space temperature cooling loads and to save operating energy.Supply fan speed shall modulate based on supply air duct static pressure. Cooling capacity shall modulate based on supply air temperature.

b. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.

6. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad,interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration,setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable.Controller shall be capable of communicating and integrating with a LonWorks or BACnet network. Orion Controls System

2.11 CURBS

A. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.

B. Knockdown curb with duct support rails shall be factory furnished for field assembly.

C. Solid bottom curb shall be factory assembled and fully lined with curb rated 1 inch fiberglass insulation and include a wood nailer strip. Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.

PART 3 - EXECUTION

3.1 INSTALLATION, OPERATION AND MAINTENANCE

A. Installation, Operation and Maintenance manual shall be supplied with the unit.

B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.

C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

END OF SECTION

SECTION 23 81 27

SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Indoor ductless fan & coil units.

B. Controls.

1.2 RELATED REQUIREMENTS

A. Division 26 - Electrical: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2025).

C. ASHRAE Std 23.1 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant; 2019.

D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

E. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 23 01 00 - General HVAC Provisions, for submittal procedures.

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

1. Design Data: Indicate refrigerant pipe sizing.

D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

E. Project Record Documents: Record actual locations of components and connections.

F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Extra Filters: Two filters for each indoor unit.

1.5 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of documented experience and approved by manufacturer.

C. Provide five year manufacturers warranty for compressors.

D. All warranties to begin at Date of Substantial Completion as accepted by the Owner.

PART 2 PRODUCTS

2.1 SUMMARY

A. This section provided for reference only. Equipment is to be provided directly by owner through a national buying agreement.

B. The contractor shall install owner furnished mini-split system(s) as shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

2.2 MANUFACTURERS

A. Daikin.

B. Samsung.

C. LG.

D. Mitsubishi.

E. Substitutions: See Section 23 01 00 - General HVAC Provisions.

2.3 INDOOR UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

1. Location: High-wall.

2. Capacity: Refer to drawings.

3. Cabinet: Galvanized steel.

a. Finish: White.

2.4 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

1. Comply with AHRI 210.

2. Refrigerant: R-32 or R-454B

3. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.

4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1and UL 207.

B. Air Cooled Condenser: Aluminum fin and copper tube coil, with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).

1. Provide thermostatic expansion valves.

D. Operating Controls:

1. Control by room thermostat to maintain room temperature setting.

2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to 0 degrees F.

E. Mounting Pad: Roof curb, minimum 14 inches square; minimum of two located under cabinet feet.

2.5 ACCESSORY EQUIPMENT

A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:

1. System selector switch (heat-off-cool) and fan control switch (auto-on).

2. Set-up for four separate temperatures per day.

3. Instant override of setpoint for continuous or timed period from one hour to 31 days.

4. Short cycle protection.

5. Programming based on every day of the week.

6. Selection features including degree F or degree C display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.

7. Battery replacement without program loss.

8. Manufacturers:

    a. Provided by Control Contractor.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available and in correct location.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.

B. Install in accordance with NFPA 90A.

C. Install refrigeration systems in accordance with ASHRAE Std 15.

D. Pipe drain from cooling coils to nearest drain.

3.3 SCHEDULE

A. Refer to plan Schedule.

END OF SECTION

SECTION 23 84 13

HUMIDIFIERS

PART 1 GENERAL 1.1

1.1 SECTION INCLUDES

A. Humidifiers.

1.2 REFERENCE STANDARDS

A. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which humidifiers will be attached.

D. Instructions: Submit manufacturer's installation, operation and maintenance manuals.

E. Field quality control test reports.

1.4 QUALITY ASSURANCE

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

B. Comply with ARI 640, “Commercial and Industrial Humidifiers.”

C. Quality management system shall comply with ISO 9001:2015 certification.

1.5 COORDINATION

A. A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

1.6 DELIVERY, STORAGE AND HANDLING

A. Waste Management and Disposal:

1. Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.7 WARRANTY

A. Product shall be warranted to be free from defects in materials and fabrication for a period of two years from the ship date.

1.8 PART 2 - PRODUCTS

1.9 MANUFACTURER:

A. Neptronic.

B. Substitutions: See Section 23 01 00 - General HVAC Provisions.

1.10 SKE4 ELECTRIC RESISTIVE STEAM HUMIDICATION SYSTEM

A. Provide self-contained, microprocessor controlled, wall mounted, electric resistive steam

B. Humidifier shall meet the requirements of UL 998 and CSA C22.2 No.104 standards to comply with ETL certification.

1.11 HUMIDIFIER CABINET:

A. The humidifier casing shall be constructed of cold roll steel and stainless steel base with baked enamel finish to prevent rust.

B. For safety and security reasons, all components, electrical wiring and plumbing connections will not be exposed and must be contained within the cabinet of the unit.

C. The compartmentalized enclosure shall separate the plumbing, controls, and high-voltage sections, preventing heat, humidity or water transfer to the electrical sections and ensuring that the evaporation chamber remains isolated.

D. The plumbing compartment shall be equipped with a drip tray.

E. The front of the unit and the high voltage compartment shall have a lockable door to restrict access by unauthorized personnel.

1.12 EVAPORATION CHAMBER:

A. Steam shall be generated in a stainless steel cleanable evaporation chamber.

B. The evaporation chamber shall be easily serviceable and removable from the unit. No tools are required during servicing.

C. The electronic level sensing assembly remains permanently fixed and separate from the evaporation chamber.

D. The heating elements and manual reset high temperature safety cut-out switch remain fixed in place, even as the evaporation chamber is removed for service cleaning.

E. The evaporation chamber shall have a water port designed to minimize the risk of blockage caused by sediment build-up. The water port will be easily detachable for servicing by means of a single quick connect assembly. D. Immersion heating element(s):

1. Steam shall be generated by self-cleaning 800/825 Incoloy electric heating immersion elements.

2. The heating elements shall have a high expansion factor, minimizing mineral deposits and enabling most of them to break off and fall to the bottom of the chamber. E. Water level control:

F. The water level detection system shall be self-cleaning, self-calibrating and equipped with a redundancy system, consisting of a high-resolution capacitive sensor and two fail-safe resistive sensors.

G. The humidifier must have the ability to sense foam and take a corrective action by going into drain cycle.

H. For safe temperature operation, the humidifier must have both an electronic temperature sensor inside the evaporation chamber and an external bimetallic temperature cut-off.

I. Water requirements:

1. The humidifier shall operate under all types of water including tap, deionized and reverse osmosis water, with no additional parts required.

1.13 FEED WATER:

A. The supply water to the unit shall be controlled by a quiet three port solenoid valve equipped with flow regulators, to supply water into the evaporation chamber, temper the hot water during a drain and clean the water level sensors.

B. To conserve energy, any hot water skimming during normal FILLING cycle is not acceptable.

C. The humidifier shall have a check valve in the fill water line to prevent backflow of hot contaminated water into the water supply system.

D. The humidifier shall have a pulsed fill mode to ensure that boiling does not stop while the humidifier is refilling, in order to maintain a constant steam output.

1.14 DRAIN:

A. The humidifier shall have a drain pump which provides a quick drain cycle, minimizing the down time.

B. The humidifier shall have four draining strategies: periodic full drain cycle, water dilute system, AFEC and configurable drain schedule, ensuring maximum energy efficiency, optimal steam output stability and minimal steam output interruptions.

C. To enhance safety and minimize energy consumption, the humidifier shall vary the drain time periods according to variations in water conditions.

D. After 72 hours of no demand, the humidifier will go into "Tank Rinse" or end of season mode, completely draining the unit to eliminate stagnant water.

E. Manual drain valve:

1. The humidifier shall be supplied with a manual drain valve which ensures that the unit can be drained even during a power failure.

1.15 DISCONNECT SWITCH:

A. For safety reasons and to conform to local regulations, the humidifier shall have a built-in factory

1. wired disconnect switch, to easily turn off the power without opening any access doors, ensuring that the power is off when accessing the electrical panels. An external disconnect switch is not required.

1.16 CONTROLLER:

A. The humidifier shall have an alphanumeric display and control module with 8 function buttons for fast configuration and operation.

B. The Idle Screen shall display common information including humidity demand, actual steam output and state of operation. It will also indicate special diagnostic parameters such as abnormal operation, time delays, etc.

C. The humidifier shall be programmable using the menu buttons to view and configure settings including control method, %R.H. set point, control signal type, and indication on number of actual service hours.

D. After the maximum number of hours of operation before servicing is due has been exceeded, the unit will display a need for servicing and the Status Display LED on the control panel will turn red.

1.17 SD CARD:

A. The unit shall be equipped with an SD card slot, to allow for simplified troubleshooting, by storing a history log of all humidifier trends and alarms.

B. The SD card shall allow for on-site firmware upgrades.

1.18 USB CONNECTION:

A. The unit shall be equipped with a USB port, to allow on-site firmware upgrades.

1.19 SCHEDULING SYSTEM:

A. The humidifier shall be equipped with a configurable and independent scheduling system for unit operation and drain cycle, ensuring that the unit does not operate or drain when not necessary.

1.20 USER RIGHTS MANAGEMENT:

A. The electronic controller shall be equipped with a user rights management system, which simplifies operation and protects the humidifier from unwanted access by displaying only the features associated to the type of user logged in.

1.21 BUILDING AUTOMATION SYSTEMS:

A. The humidifier shall be equipped with communication protocols, including BACnet MS/TP, Modbus RTU, LonWorks, BACnet UDP/IP, or Modbus TCP/IP, for integration with a building management system (BMS).

B. These protocols shall be available via a plug-in module for simple upgrade of units already in the field.

1.22 WEB SERVICES:

A. The humidifier shall be equipped with web services enabling humidifier parameter configuration, and access to diagnostics and other functions remotely using the internet.

B. Modulating control:

C. The control modulating signal shall be 0-10 VDC or 2-10 VDC, 4-20 mA or 0-20 mA to modulate 0-100% of the capacity.

D. The maximum output (SPAN) can be minimized by using the electronic "MAX OUTPUT" setting.

E. Modulation of all elements shall be achieved using silent SSR's with zero voltage crossing detection and firing. The SSR's will be backed up by an electro-mechanical contactor.

F. To avoid harmonics and peak electrical loads, Time Proportioning modulation using only electromechanical relays will not be acceptable.

1.23 SPACE DISTRIBUTION UNIT (SDU):

A. Stainless steel manifold with integral fan to discharge vapour directly into occupied space. T. Steam distribution manifold (S.A.M.):

1.24 STEAM DISTRIBUTION MANIFOLD (S.A.M.):

A. 1. Type 304 stainless steel manifold with brass nozzle inserts which provide uniform steam distribution over entire length.

1.25 STEAM DISTRIBUTION MANIFOLD (S.A.M.E2):

A. Type 304 stainless steel manifold with brass nozzle inserts which provide uniform steam distribution over entire length, used in applications with restricted duct dimensions. V. Steam dispersion panel (Multi-Steam SD):

B. Type 304 stainless steel non-insulated tubes and header, with brass insertion nozzles to prevent condensate from escaping.

C. All tubes shall be completely factory assembled with welded connections requiring no gaskets.

D. Each dispersion tube shall be fitted with one or two rows of dispersion brass nozzles.

E. The brass nozzles shall discharge steam in diametrically opposite directions, perpendicular to airflow.

F. The nozzles extend into the interior of the steam tube, preventing condensed droplets from being dropped into the duct.

1.26 STEAM DISPERSION PANEL (MULTI-STEAM HD):

A. Type 304 stainless steel insulated tubes and header, with 304 stainless steel eyelets to prevent condensate from escaping.

B. All tubes shall be completely factory assembled requiring no gaskets.

C. Each dispersion tube shall be fitted with one or two rows of dispersion stainless steel eyelets.

D. The stainless steel eyelets shall discharge steam in diametrically opposite directions, perpendicular to airflow.

E. The eyelets extend into the interior of the steam tube, preventing condensed droplets from being dropped into the duct.

1.27 OSHPD:

1.28 THE HUMIDIFIER SHALL CONFORM TO THE REQUIREMENTS OF THE OSHPD SEISMIC CERTIFICATION.

1.29 ACCESSORIES: INCLUDE THE FOLLOWING:

A. HRO20 humidity controller: Wall mounted, modulating device with electronic display and adjustment buttons that measures from 0-100% RH and provides selectable output signals, with a control range of 10% to 90% RH.

B. HRL24 humidity transmitter: Wall mounted, programmable device with electronic display and adjustment buttons that measures from 0-100% RH, with a control range of 10% to 90% RH.

C. SHR10 wall humidity sensor: Wall mounted device that measures from 0-100% RH range and provides a 0-10VDC output.

D. SHC80 duct humidity sensor: Duct mounted device that measures from 0-100% RH range and provides a 0-10VDC output.

E. SHS80 duct humidity sensor: Duct mounted device with high limit that measures from 0-100% RH range and provides a 0-10VDC output, with a high limit control range of 20% to 90% RH.

F. SHS20 high limit humidistat: Wall mounted, ON/OFF device with a control range of 20% to 90% RH, having a built-in humidity sensor.

G. HRC20 wall humidity controller: Wall mounted, ON/OFF device with a control range of 10% to 60% RH, having a built-in humidity sensor.

H. STO2-11 outdoor temperature sensor: Set point reset from an external temperature sensor to prevent condensation on windows.

I. SHW0-11 window temperature sensor: Set point reset from an external temperature sensor to prevent condensation on windows.

J. APS-ADJ: Air pressure switch shall be diaphragm operated with pitot tube for field installation.

K. Switch shall have an adjustable set point range of 0.05"WC (1.3mmWC) to 2.0”WC (50mmWC).

L. APS: Air pressure switch shall be diaphragm operated with pitot tube for field installation. Switch shall have a fix control of 0.05” WG (1.3mmWC).

M. IDC: Provide an Internal Drain Cooler (IDC) to automatically limit drain discharge temperature. The drain water must not exceed 140°F (60°C) during normal operation.

N. Drain Cooler: Provide an External Condensate Cooler (with thermostatic valve) to automatically limit drain discharge temperature. The drain water must not exceed 140˚F (60˚C) during normal operation.

O. PUMP404CV condensate pump: High temperature device used to collect and automatically remove drain water produced by the humidifier.

P. BACnet MS/TP: BACnet Master Slave/Token Passing (MS/TP) network interface shall be provided to connect BACnet client devices with Neptronic humidifier devices.

Q. BACnet IP: BACnet IP interface shall be provided to allow for data transfer to and from devices over Ethernet using the BACnet IP Protocol.

R. Modbus RTU: Modbus communication protocol shall be provided over serial line in the RTU mode, to provide a Modbus network interface between client devices and Neptronic humidifier devices.

S. Modbus IP: Modbus communication protocol shall be provided with a TCP interface running on Ethernet and to provide a Modbus network interface between client devices and Neptronic humidifier devices.

T. LonWorks: Echelon LonWorks FTT 2 wires communication network protocol shall be provided for use in building automation applications.

U. Duct distribution manifold complete with supply hose.

PART 3 EXECUTION

2.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

END OF SECTION