PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required to furnish, install, and test all hangers, supporting devices, and appurtenances shown, specified or required for pipes, fittings, valves, and other in-line equipment, complete and operational.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete

B. Section 03 60 00 – Grouting

C. Section 05 05 13.01 – Galvanizing

D. Section 05 50 00 – Metal Fabrications

E. Section 09 91 00 – Painting

F. Section 23 07 19 – HVAC Piping Insulation

G. Section 23 21 13 – Hydronic Piping

H. Section 40 05 07 – Hangers and Supports for Process Piping

1.04 REFERENCES

A. The Manufacturers Standardization Society of the Valve and Fitting Industry:

1. MSS SP-58 – Pipe Hangers and Supports – Materials, Design and Manufacture.
2. MSS SP-59 – Short Radius Welding Fittings.
3. MSS SP-69 – Pipe Hangers and Supports – Selection and Application.
4. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.
5. MSS SP-90 – Guidelines on Terminology for Pipe Hangers and Supports.

B. ASTM A 36 – Standard Specification for Carbon Structural Steel.

C. ASTM A 48 – Standard Specification for Gray Iron Castings.

D. ASTM A 123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E. ASTM A 276 – Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

F. ASTM A283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars.

G. ASTM A778 – Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

H. ASME – B31.1 – Power Piping.

I. N.Y. Spec 32-P-6 – Pipe, Special Castings, Valve Box Castings: Cast-Iron.

J. Latest Edition of the New York State Building Code.

1.05 DESCRIPTION

1. See Specification Section 40 05 07 Part 1.05

1.06 QUALITY ASSURANCE

A. Qualifications of Manufacturer and Pipe Support Designer:

1. Pipe hangers, supports, and appurtenances shall be standard products of the manufacturer specified herein.

2. Each type of hanger and support shall be the product of a single manufacturer.

3. The pipe support designer shall have a minimum of five (5) years of experience in the design of pipe supports and shall show evidence of having completed at least five (5) substantially similar, successful pipe support projects of equal complexity as the systems specified.

a. The pipe support designer shall be a New York State Registered Professional Engineer.

B. Supply and Compatibility

1. All hangers and supports for piping included in this section shall be provided by the Contractor through a single, qualified pipe manufacturer.

2. The pipe and fittings shall be designed, fabricated, and installed in accordance with standards referenced herein.

C. Regulatory Requirements:

1. All hangers and supports shall conform to the applicable requirements of ASME B31.1, MSS SP-58, SP-59, SP-69 and SP-90, except as modified herein, and be of standard manufacture wherever possible, and best suited for the service required.

2. Unless otherwise approved, all hangers, supports and concrete inserts shall be listed with Underwriters' Laboratory, Inc

1.07 SUBMITTALS

A. Contractor shall submit the Shop Drawings for approval of the Engineer. Submittals shall include, but not be limited to:

1. Name and qualifications of the New York State registered professional engineer to design the hanger and support systems and prepare the associated signed and sealed shop drawing submittals.

2. Detailed Shop Drawings showing all hangers, supports, restraints and expansion joints for each piping system. Shop Drawings shall be at a minimum scale of 3/16-inch equals one foot and shall show location, installation, material, loads, forces, stresses and deflections of all hangers and supports, expansion joints, racks, frames, braces, guides, anchors and related ancillary support system components. Reaction forces imparted to structures to which hangers and supports are attached shall be shown. At a minimum, the detailed drawings shall include but not be limited to:
    a. Scaled details of the device with dimensions.
    b. A table of applied forces and moments.
    c. A complete bill of materials.
    d. An isometric showing the applied forces and moments.
    e. Detailed connections to existing structure.
    f. Shop and field welds.
    g. Drawings shall locate components with each component identified by catalog number and show drawing detail matching the marking number for cross referencing.
    h. Anchoring Devices: Design, size and space support anchoring devices, including anchor bolts, inserts and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
    i. Tabulation of each size and type line to be supported and the support type and spacing to be used for each.
3. All drawings with required design calculations, signed and sealed by a New York State registered professional engineer.
4. Design calculations, prepared, signed, and sealed by the New York State registered professional engineer for each type of hanger, support, attachment, restraint, and anchor including but not limited to the following:
    a. Pipe stress analysis for static, dynamic, continuous and occasional loading demonstrating satisfaction of design requirements. Analysis shall include but not be limited to all loads and forces on the hangers, supports, restraints, and their reaction forces including but not limited to expansion, contraction, load, thrust, and surge as well as all other design requirement load, movement forces and stressors identified in Part 1 of this specification section.

b. Calculations associated with the design requirements described within this specification section and as indicated in the reference standards listed in Part 1 of this specification section.

c. Calculations shall be provided for each type of hanger, support, brace, attachment, and anchor.

5. Manufacturer's catalogs and engineering data on all hangers and supports, including load ratings, materials, installation details, maintenance information on hangers and support systems.

6. Contractor shall submit certification stating that all pipes and appurtenances connected to equipment are supported such that the pipes impart no stress nor load on the equipment.

B. Each submittal shall include the following:

1. A unique identification number and revision level.

2. Professional Engineer's seal and signature of the New York State registered professional engineer who prepared the hangers and support systems design calculations, system design shop drawings and related submittal information

1.08 DELIVERY, STORAGE, AND HANDLING

A. Equipment and materials shall be delivered to the Site to ensure uninterrupted progress of the Work. Pipe hanger inserts which are to be embedded in cast-in-place concrete shall be delivered in ample time not to delay the Work.

B. Equipment and materials shall be stored to permit easy access for inspection and identification and shall be kept in covered storage off the ground, using pallets, platforms or other supports. They shall be protected from condensation, corrosion, and deterioration.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not used.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

1.11 DESIGN REQUIREMENTS

A. Design, size and locate hangers, pipe anchors, expansion joints, pipe guides, and support systems throughout the facilities, whether shown or not.

B. Contractor shall visit the Site, conduct measurements, and coordinate with existing conditions and other trades to determine the exact route of piping and placement of all required pipe hangers and supports.

C. Contractor shall provide hangers and supports of sufficient strength to maintain the pipelines and appurtenances in proper position and alignment under all operating conditions.

D. Contractor shall provide the services of a New York State Registered Professional Engineer to design the supports for all pipelines and appurtenances, for all weights, forces and applied pressures. In the design of hangers, supports and anchors, unless otherwise shown or specified, pipe pressures shall be the maximum test pressures specified for pipelines carrying gases and twice the maximum test pressures specified for pipelines carrying liquids. The pipe support designer shall have a minimum of 5-year experience in the design of pipe supports and have completed at least 5 successful pipe support projects of equal complexity as the systems specified.

E. Hangers and supports design shall include load and movement calculations. Analyze each system for all loads and forces on the hangers, supports and restraints and their reaction forces transmitted to the structure to which they are attached. As a minimum, the following loads shall be included in hangers and support design and pipe stress analysis:

1. Gravity force, including weight of pipeline, insulation and appurtenances, contents, etc.
2. Thermal expansion force developed by the restraint of free end displacement of the piping.
3. Hydrostatic forces developed by internal pressure during operation of the piping system.
4. Loading due to expansion joint reaction forces.
5. Wind, snow, and ice loads for all exterior, exposed piping in accordance with the New York State Building Code. Refer to the Structural Notes on the Drawings for site- and structure-specific design criteria.
6. Buoyancy up to the latest published FEMA 500-year flood plain plus 30-inches of water uplift pressure.
7. Pressure waves produced by sudden changes in fluid momentum commonly referred to as water hammer.
8. Safety valve thrust loads.
9. Design loads that are shown and/or specified shall be supplemented by the standard minimum loads described in the listed standard references section

in Part 1 of this specification section to the extent that the most stringent provisions are utilized in developing loads.

F. Supports, guides and anchors for flexible couplings and expansion joints shall be in accordance with the coupling and joint manufacturer's specification and the standards of the Expansion Joints Manufacturers Association.

G. Wherever possible, pipe supports shall be designed using manufacturer's standard catalog products.

H. Special support and hanger details may be required and shall be provided for instances where standard catalog supports are not applicable.

I. Hangers and Supports for piping systems subject to thermal expansion and contraction, or to similar movements imposed by other sources, shall be designed to provide flexibility, and a pipe stress analysis shall be provided.

J. Where resonance with imposed vibration and/or shock occurs during operation, suitable dampeners, restraints, anchors, etc., shall be added to remove those effects.

K. Existing Support Systems: In order for existing support systems to be accepted as supports for new work, the Contractor shall demonstrate via calculations that existing support systems are adequate for the additional load. Where the existing support system are not adequate for the additional load the Contractor shall strengthen and/or supplement the existing support systems to account for the additional load.

L. Hangers and supports shall conform to the requirements specified in the standard references identified in the references section of Part 1 of this specification section, including but not limited to ASME B31.1, MSS SP-58, and MSS SP-127. Hangers and supports shall be of standard manufacture wherever possible and shall be best suited for the service required.

M. Unless otherwise approved, all hangers, supports and concrete inserts shall be listed with Underwriters' Laboratory, Inc.

N. No attempt has been made to show all required pipe supports or expansion joints on the Drawings. The presence or absence of pipe supports and/or details on any drawings shall not relieve the Contractor of the responsibility for providing them throughout the Work at no increase to Contract cost.

O. Stressors in hangers, rods and brackets shall be in accordance with Table 2 of MSS-SP-58.

P. All hangers and supports shall conform to the applicable requirements of ASME B31.1, MSS SP-58, SP-59, SP-69 and SP-90, except as modified herein, and be of standard manufacture wherever possible, and best suited for the service required.

Q. General Requirements:

1. Pipe and appurtenances connected to equipment shall be supported in a manner to prevent any stress being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, certification shall be submitted stating that requirements have been complied with.
2. Where practicable, piping shall be run in groups and parallel to building walls. A minimum clearance of one inch shall be provided between pipe and other work.
3. Piping and pipe hangers shall be located a minimum of 8'-0" above finished floor along general corridor walk way paths and equipment aisles.
4. Piping, hangers, and supports shall not obstruct access to existing valves and equipment for servicing and operation.
5. Hangers or supports shall be provided at all locations where piping changes direction.
6. Hangers and supports shall be capable of adjustment after placement of piping.
7. The number of different types of hangers and supports provided shall be kept to a minimum.
8. Suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub or flanged end.
9. Vertical piping shall be supported at each floor and between floors by stays or braces to prevent rattling and vibration.
10. Hanger rods shall be straight and vertical.
11. Chain, wire, strap or perforated bar hangers shall not be used.
12. Hangers shall not be suspended from piping.
13. Contact between dissimilar metals shall be prevented by use of copper plated, rubber or vinyl coated hangers or supports.
14. Hangers and supports shall provide for expansion and contraction throughout the full operating temperature range.
15. Any required pipe supports, for which the supports called for in this Section are not applicable, shall be fabricated or constructed from standard stainless steel shapes, concrete and anchor hardware, and shall be subject to the approval of Engineer.
16. Where hanger or support spacing does not correspond with joist or rib spacing, structural steel channels shall be attached to joists or ribs, and the pipes suspended therefrom.

17. All points of adjustment for pipe and duct hanger rods shall be locked securely in place using double-nutting. Double-nutting means two nuts torqued directly against each other under each point of adjustment in addition to a third nut on top of the bracket. Damaging threads or tack welding as a method of locking adjustment is not permitted.

18. All threaded assemblies shall be double nutted or provided with pinned nuts. Alternately, tack welding of bolted assemblies may be acceptable unless provisions for vertical adjustment is required.

19. Except where otherwise shown or required, horizontally installed valves 6-inches and larger shall be supported on each side of the valve, by pipe hangers or supports.

20. At all flexible couplings, supports shall be placed on each side and as close to the coupling as possible. Supports shall be the guide type which prevent axial movement from resulting in pipe deflection and misalignment.

21. Supports, anchorage and guidance for grooved end pipe shall be in accordance with the applicable sections of these Specifications and the recommendations of the manufacturer. The hangers and support details shown on the drawings are supplementary to this specification and supplementary to the standard references listed in this specification. In the event of conflict between the drawings and the Specifications, the most stringent requirement shall dictate.

22. In the design of hangers, supports and anchors, unless otherwise specified, pipe pressures shall be the maximum test pressures specified for pipelines carrying gases and twice the maximum test pressures specified for pipelines carrying liquids.

23. Wherever practical, pipe supports shall be designed in general alignment with the pipe support assemblies shown on the drawings with any required modifications and enhancements necessary.

24. Support arrangements shall be coordinated to maintain access for operations personnel, maintenance personnel and for removal of equipment.

25. Hangers and supports shall be designed, furnished, and installed to provide the piping elevations shown on the drawings.

26. Hangers and supports shall be coordinated with equipment, valve, and instrument access requirements as recommended by the respective manufacturers and as shown on the drawings so as not to encroach upon operations and maintenance access ways and access areas.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not used.

2.02 MATERIALS / EQUIPMENT

A. General:

1. See Specification Section 40 05 07 Part 2.02.A – Materials/Equipment, General

B. Materials:

1. See Specification Section 40 05 07 Part 2.02.D – Materials/Equipment, Materials

C. Baseplates for anchoring supports to the floor shall be Type 316 stainless steel.

D. Only new materials shall be provided.

E. Proprietary fiberglass reinforced plastic supports and hangers for use with small diameter chemical and thermoplastic pipe shall be as specified herein and approved by the Engineer.

F. Hangers and Supports shall be of the following types:

1. See Specification Section 40 05 07 Part 2.02.C – Materials / Equipment, Types

G. Hanger Sizing:

1. See Specification Section 40 05 07 Part 2.02.E – Materials/Equipment, Sizing

H. Concrete Inserts, Attachment Plates, and Clamps:

1. See Specification Section 40 05 07 Part 2.02.F – Materials/Equipment, Concrete Inserts, Attachment Plates, and Clamps

2.03 FABRICATION / ASSEMBLING / FINISHES

A. See Specification Section 40 05 07 Part 2.03 – Fabrication / Assembly / Finishes

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. See Specification Section 40 05 07 Part 2.04 – Source Quality Control / Shop Tests

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. The Contractor shall coordinate the Work such that all HVAC piping hangers, supports, and restraining systems shall be installed and secured prior to the testing or activation of the HVAC pipeline on which they are installed.

3.02 INSTALLATION

A. See Specification section 40 05 07 Part 3.02 – Installation,

3.03 FIELD TESTING / QUALITY CONTROL

A. Each pipe support system shall be tested in conjunction with the respective piping pressure test.

1. All pipe support and restraining systems shall be installed and secured prior to the testing or activation of the pipeline on which they are installed.

2. All pipe support systems shall be tested for compliance with the Contract Documents. After installation, each pipe support system shall be tested in conjunction with the respective piping pressure tests. Tests shall include cycling the piping system to duplicate operating conditions. If any part of the pipe support system proves to be defective or inadequate, as evidenced by vibration or excessive movement, it shall be repaired or augmented at no additional cost to the City.

3.04 STARTUP / DEMONSTRATION

A. Not used.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. See Specification section 40 05 07 Part 3.05 – Adjusting / Protection / Cleanup

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 34 00 – HVAC Fans

B. Section 23 74 16 – Packaged, Rooftop Air-Conditioning Units

C. Section 23 81 29 – Variable-Refrigerant-Flow HVAC Systems

D. Section 23 82 39 – Unit Heaters

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Vibration isolation equipment bases.
13. Restrained isolation roof-curb rails

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product.
    a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
    b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
2. Shop Drawings:
    a. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
    b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

3. Delegated-Design Submittal: For each vibration isolation device.
   a. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

B. Informational Submittals
1. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
2. Qualification Data: For testing agency.
3. Welding certificates.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mason Industries, Hauppauge, NY
B. Kinetics Noise Control, Dublin, OH
C. Korfund, Bloomingdale, NJ
D. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Elastomeric isolation pads
1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Smooth pattern.
5. Load-bearing metal plates adhered to pads.

B. Elastomeric isolation mounts.

1. Description: Double-Deflection, Elastomeric Isolation Mounts
2. Mounting Plates:
    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

C. Restrained elastomeric isolation mounts.

1. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    a. Housing: Cast-ductile iron or welded steel.
    b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

D. Open-spring isolators.

1. Description: Freestanding, Laterally Stable, Open-Spring Isolators
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Housed-spring isolators.

1. Description: Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
7. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
8. Top housing with threaded mounting holes and internal leveling device.

F. Restrained-spring isolators.

1. Description: Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
3. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
4. Top plate with threaded mounting holes.
5. Internal leveling bolt that acts as blocking during installation.
6. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
7. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
8. Minimum Additional Travel: 50 percent of the required deflection at rated load.
9. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
10. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed-restrained-spring isolators.

1. Description: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing
2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
3. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

4. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

H. Pipe-riser resilient supports.

1. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene
2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
3. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

I. Resilient pipe guides.

1. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene
2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

J. Elastomeric hangers.

1. Description: Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

K. Spring hangers.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

L. Vibration isolation equipment bases.

1. Steel Rails: Factory-fabricated, welded, structural-steel rails.

   a. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

   b. Include supports for suction and discharge elbows for pumps.

   c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.

   d. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

   a. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   b. Include supports for suction and discharge elbows for pumps.

   c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

d. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

3. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

a. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

b. Include supports for suction and discharge elbows for pumps.

c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

d. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

e. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

M. Restrained isolation roof-curb rails

1. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.

2. Upper Frame: Upper frame shall provide continuous and captive support for equipment.

3. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

4. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

5. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Contractor shall correct unsatisfactory conditions at no additional cost to the City before proceeding with installation.

3.02 INSTALLATION

A. Vibration control device installation

1. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

2. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

B. Vibration isolation equipment bases installation

1. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish and install all components of the system for identification of piping and equipment. The system includes the placing of identification signs and direction-of-flow arrows on all visible HVAC related plant piping, the placing of nameplates on HVAC plant equipment and structures, and painting in color of all equipment and pipe, except stainless steel or aluminum surfaces, as shown on the Contractor's working drawings submitted under the related Specifications sections for equipment, piping and valves, and as required for a complete job. This Section includes the following mechanical identification materials and their installation.

B. The Contractor shall coordinate equipment numbering scheme and pipe labeling scheme including selection of colors used with the facility prior to issuing submittal.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

B.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

B. Section 23 07 13 – Duct Insulation

C. Section 23 07 19 – Piping Insulation

D. Section 23 09 14 – Control Panels, Enclosures and Devices for HVAC

E. Section 23 21 13 – Hydronic Piping

F. Section 23 21 16 – Refrigerant Piping

G. Section 23 34 00 – HVAC Fans

H. Section 23 74 16 – Packaged Rooftop Air Conditioning Units

I. Section 23 81 29 – Variable Refrigerant Flow HVAC Systems

J. Section 23 82 39 – Unit Heaters

K. Section 23 83 43 – Infrared Radiant Heaters

L. Section 23 90 00 – Heating and Ventilating Units

1.04 REFERENCES

A. See Specification Section 40 05 97 Part 1.04 – Identification of Process Equipment

1.05 DESCRIPTION

A. This Section includes requirements for providing identification for HVAC piping and equipment in accordance with applicable standards and regulations.

1.06 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of the standards organizations and regulatory agencies, below:

1. American Society of Mechanical Engineers (ASME).

B. Qualifications of Manufacturer:

1. The identification signage shall be standard equipment of the manufacturer.

C. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

D. Provide the specified items from firms regularly engaged in the manufacture of identification devices of types and sizes required, with at least five (5) years' experience in manufacturing signs.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

a. Product data

B. Product Data: For each type of product indicated.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

D. Equipment and Valve numbering scheme.

E. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The cleaning, preservation, and packing of the identification systems for shipment shall be in accordance with the manufacturer's commercial practice.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The product shall be handled in such a manner that they may be transported and unloaded without being deformed, or otherwise damaged.

2. The product shall be protected from dirt, water, chemical, and mechanical damage and shall be stored in a dry area. Do not installed damaged product. Remove damaged materials from the Project Site.

C. Equipment and materials shall be delivered to the Site to insure uninterrupted progress of the Work.

D. Equipment and materials shall be stored to permit easy access for inspection and identification.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools necessary to service, disassemble, repair, and adjust the equipment provided under this Section, as per the requirements of the Contract Documents and/or as recommended by the manufacturer. In addition:

1. Furnish the following spare parts and accessories:

a. For every 20 pipe identification signs installed:

1) One (1) pair stainless steel mounting screws

2) One (1) pair stainless steel threaded brackets

3) One (1) pair fiber or plastic washers

4) One (1) pair stainless steel banding seals.

2. One (1) set banding tools and banding accessories

3. One (1) stainless steel banding strap, approximately 1000 ft.

4. One (1) complete nameplate mounting assembly for every twenty (20) nameplates installed.

5. One (1) stainless steel cable and splice for every twenty (20) valve identification tags.

B. Provide all spare parts and accessories suitably boxed and marked for storage and reordering.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All equipment and materials provided under this Section shall be covered by a ten (10) year manufacturer warranty, which shall commence upon Substantial Completion or Occupation or Use Prior to Completion, whichever comes first. In addition, the manufacturer shall guarantee the sign, in writing, against color fading, chipping, corroding or any other manufacturing defects.

1.11 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not used.

2.02 MATERIALS / EQUIPMENT

A. Construct fiberglass reinforced plastic identification signs and nameplates of 70 mils thick fiberglass reinforced plastic conforming to ASTM D709.

B. Provide fiberglass reinforced plastic process with a blemish free, low gloss surface of superior permanence and durability in the colors selected. Provide each identification sign and nameplate in two colors and with the legend specified. Provide the backside of the sign in black or some other uniform color.

C. Provide lettering made by silk screening or other permanent embedment of subsurface printed graphics in the material so as to produce a clear, legible sign. Do not place lettering, symbols or markings containing the name of the manufacturer on the signs. The Contract number and the year of the Contract as given on the Contract Drawings may be placed in small lettering on the front of the sign, if approved by the Engineer.

D. Provide signs for piping and valve identification with two 3/8 inch diameter grommet-protected holes located on the long side center line, the center of the hole to be ½ inch from the edge. Provide nameplates for equipment and structures with four 3/8 inch diameter grommet-protected holes, the center of the hole located ½ inch away from the edges. Provide all holes with suitable brass or stainless steel grommets.

E. Construct all signs and nameplates in conformity with ASTM D523, D638, D646, D790, D792 and D5420.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Provide identification signs and nameplates rectangular in shape and of the dimensions specified below. A dimensioned tolerance of plus or minus 1/16 inch is permissible.

1. Type of sign:

a. Pipe Identification sign dimensions:

1) 4 inches and larger outside diameter of pipe (including pipe insulation): 3-1/2 inches x 12 inches.

2) Less than 4 inches: 1-1/2 inches x 7 inches.

b. Valve Identification:

1) Valve Tags: 2-inches diameter.

2) Operating stands for valves: 1-1/2 inches x 7 inches.

c. Nameplates:

1) Equipment and structures: 3-1/2 inches x 12 inches.

B. Lettering of Signs:

1. Perform all lettering and numbering on identification signs and nameplates in block style in size and spacing to suit the size of sign, as approved by the Engineer.

2. Unless otherwise approved, limit the legend on pipe identification signs to one line and to a total of 12 letters and spaces, and the legend on equipment nameplates to two lines and a maximum of 35 letters and spaces.

3. Submit samples of the lettering to be used for fiberglass reinforced plastic signs to the Engineer for approval before manufacturing begins. Such samples must show the height, width and spacing of letters and numbers for any three (3) legends of ten or more letters and spaces.

C. Chemical Resistance:

1. Provide fiberglass reinforced plastic signs resistant to abrasion, impact, corrosion, and the following acids, alkalis, salts and solvents in accordance with ASTM D543:

a. 10% citric acid

b. 5% acetic acid

c. 3-30% sulfuric acid

d. 10% ammonium hydroxide

e. 10% sodium chloride

f. turpentine

g. mineral spirits

h. heptane

i. kerosene

j. ethyl alcohol

k. ethyl acetate

l. transformer oil

m. heavy duty detergents

n. water

2. Submit certification on acid resistance to the Engineer prior to installation.

D. Colors:

1. Code pipeline signs and equipment nameplates and finish coats of paint for pipe lines and equipment in basic colors.

2. Provide brilliant colors, distinctive shades matching as closely as possible (without custom color blending) the following basic colors as specified by the Munsell Color System (MN):
   a. White: MN-N8.8/
   b. Yellow: MN – 4Y7.5/12.8
   c. Orange: MN – 0.5 YR 4.6/12.2
   d. Red: MN – 7R 3.6/12.7
   e. Brown: MN – 2.5 YR 4.2/4.3
   f. Gray: MN – 2.5PB 5.8/1.7
   g. Charcoal: MN – 6B 5/0.4 (provide color "Charcoal: for paints equivalent to MN – N 3.75).
   h. Black: MN – N1/
   i. Blue: MN – 3PB 3.3/7.4
   j. Green: MN – 8G 4.4/6.2
3. Provide identification signs for pipelines of all sizes, mechanical equipment and valves in the color combinations specified below:
   a. Heating, Ventilating and Air Conditioning (equipment, piping, and ductwork): Green letters, Charcoal background.

E. Legend for Pipe Identification Signs:

1. Provide identification signs with the following words or abbreviations in color combinations shown to identify the pipe-line service:

Pipe Identification Signs			
		Color Code	
Legend	Service	Lettering	Background
RL	Refrigerant Liquid	Black	Yellow
RG	Refrigerant Suction	Black	Yellow
CD	Condensate Drain	White	Green

2. Number valves in conformity with the Basic Code as specified by the Operation and Maintenance Manual for the plant. Perform color combinations for such lines and valves in the same color combinations as the medium serviced.

F. Valve Identification Tags:

1. Furnish and attach valve identification tags on all valves and controls.

2. Provide round fiberglass reinforced plastic discs tags, approximately 2 inches in diameter, made in conformity with the requirements of Article 2.01. Provide tags with one 1/8 inch grommet protected hole at the top for fastening to the valve body using 1/16 inch diameter cable and splices or pins as approved. Provide grommets, cable splices and pins of stainless steel or other approved corrosion resistant material.

3. Provide numbering code for the identification tags in conformity with the Basic Code as specified by the Operation and Maintenance Manual for the plant. Assign identification numbers subject to the approval of the Engineer and in conformity with the entire piping and equipment identification system. Provide identification code for each valve and control without duplication. Provide lettering on identification tags not less than 5/16 inch high and limited to two lines. Silk-screen lettering in correct color combination; stenciled or painted numbers and lettering will not be accepted.

G. Arrows:

1. Make direction-of-flow arrows for attachment to pipe identification signs from No. 16 U.S. gauge Type 304 stainless steel, the full width of the sign. Make the arrow head with a tapered point, about 90 degrees at the apex, extending one half of the sign width from the sign edge and one half of the sign width extending under the sign. Finish all edges of the arrow. Make point with a radius of 1/4 inch for the 3-1/2 inch wide sign and a radius of 3/16 inch for the 1-1/2 inch wide sign. Punch detents on the arrows to prevent twisting of the point. Drill one hole in the arrow in alignment with the hole in the pipe identification sign so that both sign and arrow can be mounted with the same screw and bracket.

2. Submit sample direction-of-flow arrows for both sizes of pipe identification signs to the Engineer for approval before installation.

H. Nameplates:

1. Provide nameplates for equipment and structures in the same color combination as the medium they service. Legends for nameplates must follow the terminology shown. Provide numbering system as described in the Operation and Maintenance Manual.

2. The following is a representative list, not necessarily complete, of nameplate legends with appropriate color combinations to which the equipment identification number must be added:

N A M E P L A T E S			
Legend		Color Code	
First Line (1)	Second Line (2)	Lettering	Background
AIR CONDITIONING	UNIT **	White	Charcoal

N A M E P L A T E S			
Legend		Color Code	
First Line (1)	Second Line (2)	Lettering	Background
BRANCH CIRCUIT	CONTROLLER**	White	Charcoal
ROOFTOP AC UNIT	**	White	Charcoal
HEAT PUMP	**	White	Charcoal
EXHAUST FAN	**	White	Charcoal
SUPPLY FAN	**	White	Charcoal
ELEC WALL HEATER	**	White	Charcoal
GRAVITY INTAKE	VENTILATOR **	White	Charcoal
DEHUMIDIFICATION	UNIT**	White	Charcoal
ELEC DUCT HEATER	**	White	Charcoal
ELEC UNIT HEATER	**	White	Charcoal
UNIT HEATER - HW	**	White	Charcoal

(1) Nominal limit of 18 letters, numerals, and spaces.
(2) Nominal limit of 17 letters, numerals, and spaces.
*Where equipment is mounted on roofs or where exposed to the public view, such as in lobby or office areas, the color will be selected by the Architect.

**The legend on these nameplates also includes the appropriate six-digit numeral and letter designation for such equipment and structures as specified by the Operation and Maintenance Manual.

I. Additional Signs and Nameplates:

1. In addition to the legends specified above, the Engineer may order the Contractor to furnish and install additional identification signs, arrows and nameplates at no additional cost to the City. Such additional signs may be requested near completion of the Work and will be limited to no more than five (5) signs for each type specified. Conform legends and color combinations for additional signs to the requirements specified.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not used

3.02 INSTALLATION

A. Locate identification signs for piping along straight line runs at intervals of not more than 30 feet, near valves, branches and junction points, where pipes pass through walls or ceilings, and where trench piping is accessed through removable covers. Place direction-of-flow arrows as shown or required. Locate signs on large valves on or adjacent to the valve itself. Place all piping identification signs so as to be easily visible from operating locations. Locate nameplates on equipment bases and on structures at readily visible levels in such positions relative to the equipment and structures so as to prevent damage to the nameplate.

B. Mount identification signs and arrows on piping parallel and tangent to the pipe and valves by fastening with screws, plastic or fiber washers, threaded brackets and banding straps and seals. Provide screws and brackets of stainless steel with 5/16 - 18 American Standard Coarse Threads; provide No. 25 U.S. gauge stainless steel, 3/4 inch wide bands.

C. Where pipe is insulated, use care in mounting the signs so to prevent the banding straps from crushing the insulation.

D. Provide mounting assembly "Steelbinder" strapping unit as manufactured by A.J. Gerrard & Co., Des Plaines, Illinois, Independent Metal Strap Co., Inc., Roslyn, N.Y. or approved equal.

E. Mount nameplates in a manner specifically approved by the Engineer after the installation of equipment or construction of structures. Submit details of the method of fastening to the Engineer for approval. Provide fastening devices for nameplates and valves of stainless steel construction.

F. Mount valve identification signs with approved stainless steel brackets or approved stainless steel strapping in such a fashion that sharp corners or edges on signs, brackets, bolts, chain or strapping will not constitute a hazard to personnel operating the valves. Since it is impractical to detail each means of attachment in the Specifications or on the Contract Drawings, each means of attachment will receive approval only on its own merits. Submit for approval sketches of each type proposed. The attention of the Contractor is directed to Articles 3 and 4 of the Agreement, and to Article 1 of the General Conditions under paragraph entitled "Conflicts."

1. Do not attach identification tags or signs to handwheels. Use of flange bolts or bonnet bolts as a means of attachment of brackets will receive consideration. Provide all attachment devices and bolting of Type 304 stainless steel.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not used.

3.04 STARTUP / DEMONSTRATION

A. Not used.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Cleaning:

1. In addition to the requirements of the Contract Documents, the Contractor shall thoroughly clean all surfaces of the installed identification systems and remove all debris and waste materials resulting from installation.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to perform testing, adjusting and balancing of all Heating, Ventilation and Air Conditioning Systems as specified or required for proper operation.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Not Used

1.04 REFERENCES

A. Reference Standards: Comply with applicable provisions and recommendations of the following except as shown or specified:

1. ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc.), Systems Volume, Latest Edition.
    a. ASHRAE Standards 111, Practices for Measurement, Testing, Adjusting, and Balancing of Buildings Heating, Ventilation, Air-Conditioning and Refrigeration Systems
2. Test, adjust and balance systems in accord with:
    a. Associated Air Balance Council (AABC): (1989) National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems (AABC-MN-1).
    b. National Environmental Balancing Bureau (NEBB): (1991) Procedural Standards for Testing Adjusting Balancing of Environmental Systems (NEBB-01).
    c. AABC "National Standards for Field Measurements, Total System Balance, Air Distribution, Hydronics Systems, Volume One Number 81266".

1.05 DESCRIPTION

A. Heating, ventilating, air conditioning equipment shall be completely installed and in continuous operation as required to accomplish the test, adjust and balance work specified.

B. Reports shall be certified by the testing engineer that the methods used and the results achieved are as specified.

C. CORRECTIVE ADJUSTMENTS

1. Should corrective measures caused by faulty installation require retesting, adjusting and balancing, such work shall be performed at no additional expense to the City.
2. Inspections:
    a. Fan Belt Deflection: No less than 1/4-inch or more than a 1/2-inch.
    b. Finned Coils: Plate type fins shall be combed out with a fin comb for appropriate fin spacing. Helical fins shall be straightened with blunt bladed instrument.

1.06 QUALITY ASSURANCE

A. Balancers Qualifications:

1. Submit work experience or resume of proposed biographical data on employee who will directly supervise the Testing, Adjusting and Balancing Work.
2. Submit proof of certification by NEBB (National Environmental Balancing Bureau), AABC (Associated Air Balance Council), or SMACNA (Sheet Metal and Air Conditioning Contractors' National Association), or

demonstrate that the standards and experience required for certification are possessed, all to the satisfaction of the Engineer.

3. Submit a record of at least 5 years' experience in the testing and balancing contracting industry, engaged in heating, ventilating, and air conditioning work.

1.07 SUBMITTALS

Contractor shall submit Shop Drawings and material Specifications for the approval of the Engineer. Submittals shall include, but not be limited, to:

A. Data Sheets:

1. Submit samples of data sheets on each item of equipment for approval.
2. Submit data sheets on each item of testing equipment required.
3. Include name of device, manufacturer's name, model number, latest date of calibration, and correction factors.

B. Report Forms:

1. Submit specimen copies of report forms for Engineer's approval.
2. Forms shall be 8-1/2 by 11-inch paper for looseleaf binding, with blanks for listing of the required test ratings and for certification of report.
3. Reports shall be on the organizations approved forms imprinted with the company's name.
4. Certified report outlining procedure used to balance the system and the types of measuring devices used.

C. Test results shall be submitted on approved forms in a typed format.

D. Submit certified copies of required test reports to the Engineer for approval.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. INSTRUMENTS: GENERAL

1. Contractor shall provide all necessary instrumentation, tools, ladders, etc. to complete all air and hydronic balancing tests and adjustments.

2. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

3. Flow-measuring hoods (manufactured, not fabricated) shall be acceptable for measurement of ceiling diffuser performance only.

4. Contractor shall assume full responsibility for safe keeping of all instrumentation during the course of Work.

B. AIR BALANCE INSTRUMENTS

1. Provide all velometers, anemometers, pitot tubes, differential air pressure gages, manometers, hook gages, static pressure probe units, etc. as may be required to perform all air balance tests of HVAC equipment, ducts, registers, grilles, etc.

C. WATER BALANCE INSTRUMENTS

1. Provide manometers, pressure gages, and other instruments and accessories as required to balance the water system.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. SYSTEM PERFORMANCE MEASURING INSTRUMENTS

1. Provide insertion thermometers, sling psychrometers, tachometers, revolution counters, clamp-on volt-ammeter recorders, and other instruments as required to measure all facets of the complete HVAC system performance.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. All testing, adjusting, and balancing of air and hydronic systems shall be performed in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with the Contractor. Contractor shall submit one copy of the standard procedure manual to the Engineer for his records.

B. Contractor shall be solely responsible for the protection and safeguarding of his Work and shall provide every protection against accidents, injury, and damage to persons and property.

C. Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.

D. Contractor shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.

E. Contractor shall install additional access panels at no extra cost to the City, as is required to gain access to equipment concealed above ceilings, behind walls, or any other concealed space.

F. Air systems shall be tested, adjusted, and balanced with clean filters.

G. Hydronic systems shall be tested, adjusted, and balanced with clean strainers.

H. INSPECTION

1. The Contractor shall conform to the requirements of this Contract Equipment Checks:

a. Verify proper overload heater sizes.

b. Verify function of safety and operating controls.

c. Verify proper operation of equipment.

d. Report on inspection, observation and checking procedures.

3.02 INSTALLATION

A. Not Used

3.03 FIELD TESTING / QUALITY CONTROL

A. The Contractor shall be bound by this Section to test and adjust all systems and accessories covered under this Contract. The Contractor shall also comply with the requirements of testing as outlined in the individual sections. Furthermore, he shall operate and maintain these systems for certain periods of time as specified herein, and shall leave them in good working order. The Contractor shall provide all necessary equipment and labor for this work.

B. All piping systems shall be thoroughly cleaned by flushing with water, disinfected, and tested by the Contractor for tightness. Prior to testing all other piping systems, the Contractor shall submit a test procedure for each system to the Engineer for review. Pipe lines shall be flushed at a rate of at least 2.5 feet per second for a duration of minimum one hour. The units and control valves shall be isolated before flushing. The pipe line shall be flushed again after opening the valves at the units. In general, piping shall be tested hydrostatically at 1-1/2 times the maximum design pressure for which the system is intended, but not less than 100 psi. The line shall be filled with water for a period of not less than 6 hours, then subject to the indicated test pressure. Duration of test pressure shall be four (4) hours. During the pressure test there shall be no leakage. All air shall be purged from the line before pressure testing. Any leak shall be repaired in a manner acceptable to the Engineer and the system retested until all such piping shows tight.

C. Refrigerant piping must be tested before any piping is insulated or concealed. The entire refrigerant circuit must be thoroughly tested to be sure that it is absolutely tight. The system shall be tested with oil pumped, dry nitrogen. The low side of the system shall be tested at 150 psi and the high side at 300 psi. All pipe joints shall be tapped sharply with a rubber mallet and tested for leaks with a soap solution. After all leaks have been repaired, the system shall be charged with a small quantity of refrigerant and the entire system shall be checked with a halide leak detector. Once the system is found tight, it shall be allowed to stand for 6 hours with the pressure on. If any pressure drop occurs, except those due to changes in ambient temperature, the entire system shall be retested. The system shall be evacuated with a vacuum pump until vacuum of 2.5 mm Hg is achieved. Under no circumstances shall the compressor be used to evacuate the system. After evacuation, the system shall be allowed to stand for 12 hours. If no noticeable rise in pressure occurs, the system shall be charged.

D. All ductwork systems including air outlets shall be tested, adjusted and balanced for within limits of the required airflows as indicated on Drawings and specified in this Section.

E. After all final tests have been performed on all equipment and on all sub-systems installed under this Contract, including the testing of all controls specified in other Sections, and after the results from all such testing have been accepted, the Contractor shall test the overall system by demonstrating its ability to respond properly to normal changes in controlled parameters, as well as to system upsets. To facilitate this, he shall make available a minimum of two men, thoroughly familiar with the systems and equipment installed under this Contract, for a minimum of seven (7) Days to test the system by changing controlled parameters and generating system upsets as directed by the Engineer, and demonstrating that the sequential action appropriate to the particular change or upset occurs automatically. Where actual change or upset is not feasible, the Contractor shall simulate the change or the upset. Controlled parameter changes shall include, but not necessarily be limited to, any change in temperature, pressure, flow rate, fluid level, load, etc., which should result in an automatic change in the position of a control valve or control damper, in the output rate of a piece of equipment, in the normal start-up or shutdown of equipment, etc. The change in the state of the controlled device or equipment shall be shown to result in a corrective action on the controlled parameter. Upsets shall include, but not necessarily be limited to, any condition which should cause annunciation of an alarm, safety shutdown of equipment, startup of standby equipment, closing of fusible-link devices, lifting of relief valves, etc. The Contractor shall immediately restore to its original state any safety device, the state of which has been changed by its having been tested.

F. Contractor shall immediately correct any system deficiency that should come to light during testing.

G. After the overall system testing has been completed, and after all final adjustments have been made, the Contractor shall operate and maintain all new systems and equipment, Site-wide, associated therewith, for a period of thirty consecutive Days.

During this period all normal maintenance (filter replacements, strainer cleaning, periodic checks of safety devices, datalogging, etc.) shall be performed by the Contractor. If, during this period, any work beyond routine maintenance of equipment and materials installed under this Contract, should be required to maintain proper operation of the overall system, the elapsed time shall be forfeited, and a new thirty-day (30) period shall commence following the completion of the corrective action.

H. The Engineer will determine which fuel shall be burned in the boilers during these periods. All fuel and utilities required for system operation shall be provided by the City.

I. AUTOMATIC CONTROL SYSTEMS

1. In cooperation with the control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

2. Testing organization shall verify all controls for proper calibration and list those controls requiring adjustment by control system installer.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. BALANCING AND ADJUSTING

1. In addition to any other reference to balancing and adjusting specified elsewhere in these Section, the Contractor shall be bound by this portion of the Section to balance, adjust and leave in good working order all systems and accessories covered under this Contract.

2. The Contractor shall procure the services of an independent balancing and testing agency which specializes in the balancing and testing of heating, ventilating and air conditioning systems to balance, test and adjust all systems installed under this Section.

3. The Contractor shall advise the Engineer at least two weeks in advance of the date scheduled for balancing to commence; at the Engineer's discretion, the balancing shall be conducted in the Engineer's presence.

4. At least three (3) months prior to the commencement of balancing, the Contractor shall forward a detailed explanation of the balancing procedure to the Engineer for review. In general, the method shall conform to those specified by the Associated Air Balance Council or SMACNA.

5. All piping systems shall be balanced under this Section to provide the flows indicted on the Contract Drawings or in this Section.

6. Air systems shall be balanced before all hydronic and refrigerant systems.

7. Before beginning to balance the air systems the Contractor shall check, in the presence of the Engineer, all filters and coils for cleanliness, dampers (automatic, volume and fire) for correct position, all fans for proper rotation,

and temperature controls for minimum completeness to allow for proper balancing. If any of the above or other conditions are found which would not allow for proper balancing the Contractor shall take the necessary corrective actions, at his own expense, before balancing begins.

8. All heating, ventilating, and air conditioning systems shall be balanced by the Contractor by adjustment of dampers, fan sheaves, apparatus and air outlets to provide the air quantities indicated on the Contract Drawings. If necessary, adjustments of air outlets shall be made to eliminate drafts.

9. Balancing for all air systems shall be accomplished in a manner to first minimize throttling losses, then fan speed shall be adjusted to meet design conditions. All air outlets and fans shall be balanced within 5 percent of the design capacity.

10. Balancing for all hydronic systems shall be accomplished in a manner that results in the balancing valve which is hydraulically furthest from the pumps having a pressure drop of five feet at design flow, unless when wide open its pressure drops exceeds five feet, in which case, it shall be left wide open. (Inadequate pressure drop renders flow readings inaccurate; excessive pressure drop imposes needless additional head on the pumps). Balancing for the remainder of the system shall be accomplished in a manner to first minimize throttling losses. When variable speed drives are provided, pumps speed shall then be adjusted to meet design flow conditions. For each constant speed pump system having a pump motor greater than 10 HP, the following procedure shall then be followed:

    a. Record the pressure head across the pump, and the actual flow rate.

    b. For closed systems, multiply this pressure drop by the square of the ratio of the design flow to the actual flow. For open systems, include compensation for static head in performing this calculation.

11. Pump flows shall be balanced within 5 percent of the specified capacity.

12. After the systems have been balanced, the Contractor shall submit and certify to the City, a list containing the following minimum information for air outlets and equipment:

    a. Room or facility served.

    b. Size, quantity and model of air outlet or equipment.

    c. Type of air outlet or equipment.

    d. Air flow indicated on Contract Drawings.

    e. Air flow measured.

    f. GPM indicated on Contract Drawings.

    g. GPM measured.

    h. Entering and leaving water temperatures.

i. Fan cfm indicated on the Contract Drawings.

j. Fan cfm measured.

k. Fan motor running amps.

13. The Contractor shall advise the Engineer two Days in advance of the start-up of the heating and cooling water circulating systems. To be ready for start-up, the boilers, chillers, condensers and pumps and related equipment must be "off", and the system must be filled, purged, balanced and cool.

14. The Contractor shall record the following:

a. Pressure at system fill valve.

b. Pressure at pumps (inlet or outlet).

c. Pressure at building piping entries.

d. System temperature.

15. The Contractor shall start the pumps and record the following pressures:

a. System fill valve.

b. Pump inlets.

c. Pump outlets.

d. Building piping entries (supply and return).

16. The Contractor shall start heating and/or cooling equipment. Once system design temperature has been reached, and system is in equilibrium, again record the pressures listed above, as well as the temperatures at the inlets and outlets of the boilers, chillers, condensers, coils, and heat exchangers.

17. The Contractor shall submit all recorded data to Engineer for review.

18. The Contractor shall adjust any or all equipment which, in the City's opinion, is not set within acceptable limits of ±5 percent.

B. MARKING OF SETTING

1. Following approval of testing, adjusting and balancing (TAB) Verification Report, the setting of all HVAC adjustment devices including valves, and manual dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time.

C. IDENTIFICATION OF TEST PORTS

1. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leakage or to maintain integrity of vapor barrier.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required to furnish, install, and test all duct insulation complete and operational.

B. The following index of this Section is presented for convenience:

C.

D. The following schedules, attached after the end of section designation, are a part of this Section:

1. Schedule 23 07 13-1, Duct Insulation Schedule.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

B. Section 40 05 97 – Identification for Process Equipment

1.04 REFERENCES

A. Reference Standards:

1. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers.
2. ASTM C449 Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
3. ASTM C534 Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
4. ASTM C547 Mineral Fiber Pipe Insulation.
5. ASTM C552 Cellular Glass Thermal Insulation.
6. ASTM C553 Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
7. ASTM C612 Mineral Fiber Block and Board Thermal Insulation.
8. ASTM C647 Properties and Tests of Mastics and Coating Finishes for Thermal Insulation.
9. ASTM C916 Adhesives for Duct Thermal Insulation.
10. ASTM C920 Elastomeric Joint Sealants.
11. ASTM C1126 Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
12. ASTM E84 Surface Burning Characteristics of Building Materials.
13. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
14. NFPA 255 Surface Burning Characteristics of Building Materials.

1.05 DESCRIPTION

A. This Section includes requirements for providing duct insulation in accordance with applicable standards and regulations. In addition:

1. All fastenings, auxiliary equipment, accessories and appurtenances, necessary and/or required for a complete installation shall be included within the scope of Work.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the duct insulation installation.
2. Engage a firm which can show successful experience in the manufacture of duct insulation systems of scope and type similar to the required Work.

B. Contractor's Qualifications:

1. Contractor shall have at least five (5) years of experience in the installation of the Work specified. He shall employ only tradesmen with specific skills and experience in this type of Work.
2. Contractor shall have undivided responsibility as a single firm for performance and other requirements for the installation of the Work specified herein.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.

1. Underwriters Laboratories, Incorporated (UL).
2. National Fire Protection Association (NFPA).
3. Local and State Building Codes and Ordinances:
   a. New York State Building Code
   b. New York State Uniform Fire Prevention and Building Code
   c. New York State Energy Conservation Construction Code

D. General: Insulation systems including covering, mastics, adhesives, sealers and facings shall have the following Fire Hazard Classifications in accordance with ASTM E84:

1. Flame spread, 25 maximum.
2. Fuel contributed, 50 maximum.
3. Smoke developed, 50 maximum.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:
   a. Samples: Submit for approval samples of the following:
      1) Thermal Insulation - Flexible.
      2) Thermal Insulation - Rigid.
      3) Acoustical Insulation.

b. Shop Drawings: Submit for approval manufacturer's catalog literature, Specifications, and illustrations with the following information:

a) Thermal properties

b) Physical properties

c) Fire hazard ratings

d) Facing information

e) Installation instructions

f) Jointing recommendations for butt joints and longitudinal seams

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Contractor shall provide spare parts and special tools necessary to service and repair provided under this Section, and as per the requirements of the Contract Documents.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All materials, equipment, and products provided under this Section shall be covered by a 10 year manufacturer warranty, which shall commence upon Substantial Completion or Use and Occupation Prior to Completion, whichever comes first.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Duct insulation:

1. Owens Corning, Toledo, OH.

2. CertainTeed Corp., Valley Forge, PA.

3. Schuller International, Inc. (Johns-Manville), Littleton, CO.

4. No. 814 –Spin-Glas, as manufactured by Johns-Manville, Littleton, CO.

5. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Exposed Ductwork Insulation (Rigid):

1. All exposed ductwork (as identified by Schedule 23 07 13-1, Duct Insulation Schedule, located after the End of Section designation), shall be insulated with minimum 1½-in. thick (except 2-in. thick for ducts located outdoor and outside air intake plenums) glass fiber board having a density of not less than 3.0 lbs./ft^3, and a thermal conductivity of not more than 0.23 BTU·in./(h·ft^2·°F) at 75°F mean temperature.
2. The exposed ductwork insulation shall be impaled over pins welded to the duct surface on 12-in. centers.
    a. The pins shall be coated with vapor barrier adhesive, and the insulation shall then be secured with caps over the pins.
3. All joints and breaks in the vapor barrier shall be sealed with 3-in. wide strips of the vapor barrier facing.
4. All insulation shall be reinforced with corner bead.
5. The facing shall be finished with a 3-ply application of lagging adhesive, glass fabric reinforcing and a finish coat of mastic.

B. Concealed Ductwork Insulation (Flexible):

1. All concealed ductwork (as identified by Schedule 23 07 13-1, Duct Insulation Schedule, located after the End of Section designation), shall be insulated with 1½in. thick flexible fiberglass duct insulation, having a thermal conductivity of not more than 0.28 BTU·in./(h·ft^2·°F) at 75°F mean temperature.
2. The insulation shall have a reinforced foil vapor barrier facing.
3. Insulation shall be secured with 4-in. wide bands of adhesive on 12-in. centers.
4. All joints shall be sealed by adhering a 2-in. sealing lap or 3-in. strips of vapor barrier facing applied with vapor barrier adhesive.
5. On horizontal ducts over 24-in. wide, welded pins and clips shall be used on the underside on 18-in. centers.

C. Internal Duct Liner Insulation - Acoustical Insulation:

1. Type: Fiberglass duct liner board with black surface.
2. Density: Minimum 1½ lbs. per cubic foot.
3. Thickness: 1½ in. minimum.
4. Thermal Conductivity: 0.23 Btu·in./(h·ft^2·°F) at 75°F mean temperature.

D. Adhesives and Accessories:

1. Acoustical Lining Insulation Adhesive:

a. Insulation shall be applied in cut-to-size pieces attached to the interior of the duct with a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

b. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire-resistant adhesive to prevent delamination of glass fibers.

2. Mineral Fiber Insulation Cement:

a. Cement shall be in accordance with ASTM C195.

3. Lagging Adhesive:

a. Lagging adhesives shall be nonflammable and fire-resistant and shall have flame spread and smoke developed ratings of 25/50 when measured in accordance with ASTM E84.

4. Contact Adhesive:

a. Adhesive may be dispersed in a non-halogenated organic solvent with a low flash point (flash pint less than minus 25°F when tested in accordance with ASTM D3278) or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200°F.

b. The adhesive shall be nonflammable and fire resistant.

5. Caulking:

a. Caulking shall be in accordance with ASTM C920.

6. Corner Angles:

a. Nominal 0.016 in. type 316 stainless steel 1-in. × 1-in. with factory applied kraft backing and adhesive.

7. Finishing Cement:

a. Mineral fiber hydraulic-setting thermal insulating cement ASTM C449.

8. Fibrous Glass Cloth and Glass Tape:

a. Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E84.

9. Staples shall be outward clinching Type 316 stainless steel.

10. White Vapor Retarder All Service Jacket (ASJ):

a. Shall be used on hot/cold pipes, ducts, or equipment.

b. Vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting.

11. Weatherproof Jackets:

a. Type 316 stainless steel jackets shall be smooth sheet, 0.016 in. nominal thickness.

b. Corrugated metal jacket shall not be used outdoors for insulated ducts.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Source Quality Control: Perform the following tests and inspections at factory.

1. Flame Spread

2. Smoke Developed

3. Fuel Contributed

B. Manufacturer's Markings:

1. Stamp or label with manufacturer's name and brand every package or standard container of covering, adhesive and coating delivered to the job Site for use.

2. Exposed side of insulation shall be legibly labeled by the manufacturer to show thickness, type and manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Contractor shall install all Work in complete accordance with the manufacturer's instructions and recommendations, and the approved Shop Drawings.

B. Sequencing: Obtain the Engineer's approval of insulation, adhesives, coatings and method of installation before installing any insulation.

C. All duct leaks shall be sealed prior to installation of external insulation to prevent billowing and damage to insulation.

D. Contractor shall ensure that all surfaces are clean and dry before applying insulation.

E. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.

F. Contractor shall ensure that ductwork has been inspected and released for application of insulation

G. Contractor shall not install damaged insulation until repairs are made in accordance with manufacturer's written instructions and approval by Engineer.

1. Only minor repair work will be permitted in the field.

2. All damaged insulation requiring remedial work shall be returned to the manufacturer for repair or replacement.

3.02 INSTALLATION

A. Install duct insulation in complete accordance with the manufacturer's printed instructions and the approved shop drawings.

B. Install insulation to make surfaces smooth, even and substantially flush with adjacent duct insulation.

C. Duct sizes indicated on Drawings are clear inside dimensions. Increase duct sizes to give designated inside dimensions when internal insulation is used.

D. Thickness of rigid insulation shall be greater than the seams or angles of ductwork to which it is applied.

E. Duct insulation shall be continuous through sleeves and prepared openings.

F. Insulation shall terminate at fire dampers and flexible connections.

G. Vapor barrier materials shall be applied to form a complete unbroken vapor seal over insulation.

H. Provide Type 316 stainless steel jacketing and waterproof sealants for insulated ducts exposed to outdoor.

I. Field Painting shall comply with the requirements of Section 09 91 00, Painting.

J. Identification markers and labels shall be in conformance with the Contract Documents and Section 40 05 97, Piping and Equipment Identification.

3.03 FIELD TESTING / QUALITY CONTROL

A. Furnish the services of a qualified manufacturer's representative to check and approve all insulation as well as conduct field testing, in accordance with the requirements of the Contract Documents. In addition:

1. Contractor shall verify that all Work furnished and installed conforms to the requirements the Contract Documents.

2. Reports: Submit a report from the manufacturer of each visit to the Site. Reports shall provide complete information on time, schedule, tasks performed, persons contacted, problems corrected, test results, instruction and all other pertinent information.

B. SCHEDULES

1. Thermal Insulation - Rigid: The following exposed ductwork exposed in room shall be insulated:

a. All outside air intake ducts and plenums from the outside air intake louver, outside air intake shaft, or roof mounted intake up to the point where the duct or plenum is connected to the heating and

ventilating units, air conditioning units, or supply fans in heated and air conditioned spaces.

b. All exhaust and return air ductwork from air conditioned spaces.

c. All supply and return air ductwork associated with Air Conditioning Units.

d. All heated and air conditioned ductwork located in unheated spaces.

e. All heated and air conditioned ductwork located outdoor shall be insulated and covered with weatherproof stainless steel jacket.

f. Where indicated on the Contract Drawings.

2. Thermal Insulation - Flexible: The following ductwork located above hung ceiling shall be insulated:

a. All supply, exhaust and return ductwork associated with air conditioning units.

b. All outside air intake ducts and plenums from the outside air intake louver, outside air intake shaft or roof mounted intake up to the point where the duct or plenum is connected to the heating and ventilating units and supply fans.

c. Where indicated on the Contract Drawings.

3. Acoustical Insulation: Ductwork shall be internally insulated as specified in the Contract Documents and where indicated on the Contract Drawings.

4. Insulation Thickness: All ductwork insulation shall be 1½-in. thick except for outside air intake plenum and outside air ductwork insulation which shall be 2-in. thick.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Remove all debris, waste materials and loose foreign matter resulting from installation.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 23 07 13 – Duct Insulation

C. Section 40 42 13 – Process Piping Insulation

1.04 REFERENCES

A. Referenced Standards:

1. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
2. ASTM C450 Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
3. ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
4. ASTM C585 Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
5. ASTM C591 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
6. ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
7. ASTM C871 Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
8. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
9. ASTM D1644 Standard Test Methods for Nonvolatile Content of Varnishes
10. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
11. ASTM E96 Standard Test Method for Water Vapor Transmission of Materials.
12. ASTM F1249 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
13. Building Code of the State of New York.
14. New York State Energy Conservation Code.

1.05 DESCRIPTION

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Refrigerant suction and hot-gas piping, indoors and outdoors.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

b. Detail attachment and covering of heat tracing inside insulation.

c. Detail insulation application at pipe expansion joints for each type of insulation.

d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

e. Detail removable insulation at piping specialties.

f. Detail application of field-applied jackets.

g. Detail application at linkages of control devices.

B. Informational Submittals

1. Qualification Data: For qualified Installer.

2. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

3. Field quality-control reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Insulation Materials

1. Flexible Elastomeric Insulation:

a. K-Flex USA

b. Armacell LLC

c. Airex Manufacturing

d. Aeroflex USA

e. Or approved equal.

2. Polyisocyanurate Insulation:

a. Johns Manville, a Berkshire Hathaway company

b. Or approved equal.

B. Adhesives

1. Childers Brand

2. Foster Brand

3. Or approved equal.

C. Mastics

1. Childers Brand

2. Foster Brand

3. Knauf Insulation

4. Or approved equal.

D. Lagging Adhesives

1. Childers Brand

2. Foster Brand

3. Vimasco Corporation

4. Or approved equal.

E. Sealants

1. Polyisocyanurate Insulation:

a. Childers Brand
b. Foster Brand
c. Owens Corning
d. Or approved equal.

2. FSK and Metal Jacket Flashing:
a. Childers Brand
b. Foster Brand
c. Mon-Eco Industries, Inc.
d. Or approved equal.

F. Tapes
1. FSK Tape:
a. Knauf Insulation
b. Avery Dennison Corporation
c. 3M Industrial Adhesives and Tapes Division
d. Or approved equal.

G. Securements
1. Bands:
a. RPR Products, Inc.
b. Johns Manville; a Berkshire Hathaway company
c. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Insulation Materials
1. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials shall be applied.
2. Products shall not contain asbestos, lead, mercury, or mercury compounds.
3. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

6. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

7. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

   a. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 Days of aging.

   b. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested by ASTM E 84.

   c. Fabricate shapes according to ASTM C 450 and ASTM C 585.

B. Adhesives

1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

2. Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

3. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mastics

1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

2. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

   a. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

   b. Service Temperature Range: Minus 20 to plus 180 deg F.

   c. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

   d. Color: White.

3. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.

   b. Service Temperature Range: 0 to 180 deg F.

   c. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.

d. Color: White.

4. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   b. Service Temperature Range: Minus 50 to plus 220 deg F.
   c. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   d. Color: White.
5. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F.
   c. Solids Content: 60 percent by volume and 66 percent by weight.
   d. Color: White.

D. Lagging Adhesives
1. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

E. Sealants
1. FSK and Metal Jacket Flashing Sealants:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Fire- and water-resistant, flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 40 to plus 250 deg F.
   d. Color: Aluminum.

F. Field-Applied Jackets
1. Field-applied jackets shall comply with ASTM C 1136, Type I, unless otherwise indicated.
2. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

3. Metal Jacket:
    a. Stainless-Steel Jacket: ASTM A 240/A 240M.
    b. Sheet and roll stock ready for shop or field sizing.
    c. Material, finish, and thickness are indicated in field-applied jacket schedules.
    d. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
    e. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    f. Factory-Fabricated Fitting Covers:
        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

G. Tapes
1. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
    a. Width: 3 inches.
    b. Thickness: 6.5 mils.
    c. Adhesion: 90 ounces force/inch in width.
    d. Elongation: 2 percent.
    e. Tensile Strength: 40 lbf/inch in width.
    f. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

H. Securements
1. Bands:
    a. Stainless Steel: ASTM A 240/A 240M, Type 316; 0.015 inch thick, 1/2 inch wide with closed seal.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application. Before insulating, apply a corrosion coating to insulated surfaces as follows:

C. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

D. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

E. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

F. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 INSTALLATION

A. General Installation Requirements

1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
5. Install multiple layers of insulation with longitudinal and end seams staggered.
6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
7. Keep insulation materials dry during application and finishing.
8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
9. Install insulation with least number of joints practical.
10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    a. Install insulation continuously through hangers and around anchor attachments.
    b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
    c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
    d. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
11. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
12. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
13. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
14. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
15. For above-ambient services, do not install insulation to the following:

a. Vibration-control devices.

b. Testing agency labels and stamps.

c. Nameplates and data plates.

d. Manholes.

e. Handholes.

f. Cleanouts.

B. Penetrations

1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

a. Seal penetrations with flashing sealant.

b. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

d. Seal jacket to roof flashing with flashing sealant.

2. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

a. Seal penetrations with flashing sealant.

b. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

c. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

d. Seal jacket to wall flashing with flashing sealant.

3. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

4. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

a. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

5. Insulation Installation at Floor Penetrations:
   a. Pipe: Install insulation continuously through floor penetrations.
   b. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

C. General Pipe Insulation Installation
1. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
2. Insulation Installation on Fittings, Flanges, and Unions:
   a. Install insulation over fittings, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   b. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   c. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   d. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   e. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   f. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   g. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

3. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

4. Install removable insulation covers at locations indicated. Installation shall conform to the following:

   a. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

   b. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

   c. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

   d. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

D. Installation of Flexible Elastomeric Insulation

1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Insulation Installation on Pipe Flanges:

   a. Install pipe insulation to outer diameter of pipe flange.

   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

   d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install mitered sections of pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Installation of Polyisocyanurate Insulation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
   b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
3. Insulation Installation on Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

F. Field-Applied Jacket Installation
1. Where FSK jackets are indicated, install as follows:
   a. Draw jacket material smooth and tight.
   b. Install lap or joint strips with same material as jacket.
   c. Secure jacket to insulation with manufacturer's recommended adhesive.

d. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.

e. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

2. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints

G. Finishes

1. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

2. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3. Do not field paint stainless-steel jackets.

H. Piping Insulation Schedule, General

1. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

I. Indoor Piping Insulation Schedule

1. Condensate and Equipment Drain Water below 60 Deg F:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 1 inch thick.

2) Polyisocyanurate: 1 inch thick.

2. Refrigerant Suction and Hot-Gas Piping:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 1 inch thick.

2) Polyisocyanurate: 1 inch thick.

3. Refrigerant Suction and Hot-Gas Flexible Tubing:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 1 inch thick.

J. Outdoor, Aboveground Piping Insulation Schedule

1. Refrigerant Suction and Hot-Gas Piping:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 2 inches thick.

2) Polyisocyanurate: 2 inches thick.

2. Refrigerant Suction and Hot-Gas Flexible Tubing:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 2 inches thick.

K. Indoor, Field-Applied Jacket Schedule

1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

2. If more than one material is listed, selection from materials listed is Contractor's option.

L. Outdoor, Field-Applied Jacket Schedule

1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

2. If more than one material is listed, selection from materials listed is Contractor's option.

3. Piping, Concealed:

a. Stainless Steel, Type 316: 0.016 inch thick.

4. Piping, Exposed:

a. Stainless Steel, Type 316: 0.016 inch thick.

3.03 FIELD TESTING / QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall employ the services of a Heating and Ventilating I&C Subcontractor who, acting through the Contractor shall, furnish, install, calibrate, test, tune, document and place in satisfactory operating condition the various local Heating and Ventilating Control Systems (HCS) as described herein. These systems shall include all control panels, instruments, controls, devices, interconnections, PLCs, etc., including those provided as part of packaged systems such as HVAC units, etc. For the purposes of these Specifications, unless otherwise noted, the term furnish shall be understood to include, selecting, sizing, furnishing and delivering all equipment, mounting appurtenances, software and services, preparing and submitting all required documentation, providing setup, testing, calibration, tuning, configuration and training services for all equipment provided. In addition, detailed installation and connection instructions and exact locations shall be provided. The term install shall be understood to include delivery to the area; mounting; electrical, process and mechanical connections; installation of supports; cleaning and protection of all equipment provided under this Contract. The responsibilities of the HVAC I&C Subcontractor, henceforth referred to as the HCS Supplier, shall also include but not be limited to, detailed system configuration and design, system integration, furnishing of all instruments and equipment, installation supervision, programming, supervision, calibration tuning, testing and training, as well as all required HCS, whether indicated or not. The Contractor shall provide the installation and connection (electrical, process and mechanical) of all equipment furnished herein.

B. The following index of this Section is presented for convenience:

C. Article Title

D. The scope of the equipment controlled by the HCS shall include all the space heating, cooling, ventilating, and air conditioning systems provided under this Contract.

E. The HCS supplier shall include all equipment, materials, supervision, labor, tools and documentation required to furnish, install, test and place in operation a complete and operable HVAC instrumentation, control and monitoring system as defined by the Contract Documents. While the scope of work for this Section shall include all Heating, Ventilating and Air Conditioning Contract Drawings and Specifications, the HCS supplier is specifically directed to information contained, equipment schedules, control and schematic drawings and Specification 23 09 00 through 23 09 93. The system shall include all measuring elements, instruments, controls, panels, signal converters, transmitters, local control panels, digital and analog hardware and software, PLCs, workstations, interconnecting conduit and wiring, control elements and such accessories as shown, specified, and/or required to provide the required functions and operability.

F. The Contractor shall review in detail the Contract Drawings and Specifications for the complete scope of work including mechanical process systems. Close coordination shall be provided.

G. It is the purpose and intent of these Specifications to construct a complete and working installation of top quality and reliability. Items of equipment or materials which may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

H. While the Contractor is responsible for all Work associated with the Project, the major responsibilities of the HCS Supplier shall include but not be limited to the following:

1. Furnish and supervise the installation of all HVAC systems, instrumentation, controls and system monitoring. Provide installation supervision, supports, hardware and appurtenances as required, scheduled and/or shown in the Contract Documents. Coordinate all aspects of

equipment and system monitoring and control with Contract requirements, mechanical equipment suppliers, other vendors and Subcontractors. Submit working drawings and shop drawings for all instruments, equipment, services and Work provided. Indicate, detail and supervise the location and installation of all process taps required for system implementation.

2. Supervise and direct the installation of all instrumentation and control equipment provided under this Contract.

3. Provide a detailed design for, assemble, test and furnish all control panels and enclosures as required, specified or shown on the Contract Drawings and Specifications. Local control panels shall be furnished and installed for all equipment provided under this Contract including but not limited to all, fans, heating and ventilating equipment, air conditioning systems, and all auxiliary equipment.

4. The HCS Supplier shall participate in the production of the Conduit and wiring diagrams required under this Contract. It shall review and approve all conduit, wiring and grounding system drawings pertaining to the HCS for proper routing, correct and adequate wire type and count, adequate conduit size and appropriate grounding. The HCS Supplier shall indicate by its approval that the conduit and wire systems are adequate and will permit him to install and operate the system as required.

5. Prepare detailed loop and point to point wiring diagrams for the entire HCS showing all instrumentation and control system terminations for, control, monitoring, signal, communication and ground wiring, all wiring and terminations between field instruments, equipment control panels, local control panels, PLCs and I/O, motor control centers and associated equipment as required. Wiring and terminations to panels and equipment provided by the HCS Supplier and those of all other HVAC equipment and devices provided by vendors and Contractors shall be shown and coordinated.

6. Provide installation supervision, calibration, testing, training, start-up and system tuning services for all instrumentation, control and monitoring equipment and systems associated with the HCS.

7. Furnish the installation and mounting hardware, brackets, stands, etc., necessary for all controls, instruments, etc., furnished under this Contract.

8. Furnish and direct the installation of all heating, ventilating and air conditioning instruments, controls, sensors, control panels, etc.

9. Furnish onsite training as specified for all equipment and services provided.

10. Furnish, supervise the installation and connection of, configure, test and place in operation, all local and remote I/O associated with the system in

local control stations, equipment panels, enclosures, motor control centers and as indicated or required.

11. Perform all field testing, tuning, startup and system optimization activities as required in the related section of this Division, and as specified herein.

12. Perform and participate in all startup, testing and tuning activities required for all equipment and systems provided under this Contract and as indicated in Specifications 23 09 15 – Instrumentation and Controls System Testing, Installation and Startup for HVAC, 23 05 93 – Testing, Adjusting and Balancing for HVAC.

I. The Contractor shall:

1. Retain the services of a duly licensed Electrical Subcontractor who, acting through the Contractor and under the direction of the HCS Supplier, shall provide a detailed design for, furnish and install all conduit, wiring and electrical system as required to implement the entire HCS, Conduit and wire shall be furnished and installed as required for all HVAC. The Electrical Subcontractor shall perform all electrical work required under this Contract including all required testing. The electrical system shall include but not be limited to, all equipment, controls, instruments, panels, conduit, raceways, wire, cables, junction boxes, terminal strips, enclosures, supports, hardware, accessories, grounding, etc. required to provide a complete installation. Power and control to damper actuators, etc. shall be provided herein. In most cases, power conduit runs to associated equipment and control panels shall be provided under the Electrical scope of work. Power and control conduit and wire for major equipment, from the MCC to that equipment, shall be provided where shown on the Electrical drawings. The Contractor shall furnish and install all conduit and wire from his control panels and equipment to all instrumentation, control devices, MCCs, control panels, actuators, etc. as required to implement the system. All electrical work provided under this Contract shall be in accordance with the requirements of Division 26, Specifications, Contract Drawings, the NEC and all applicable state and local codes. The electrical Subcontractor shall participate in all startup and testing activities required under this Contract.

2. Furnish, install, test and place in satisfactory operating condition a complete electrical system consisting of equipment, conduit, wire, raceways, etc. as indicated and as required to provide a complete and operational control and monitoring system for all HVAC equipment including heating, ventilating and air conditioning equipment, etc. provided under this Contract.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or Allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

B. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

C. Section 23 09 14 – Control Panels, Enclosures and Devices for HVAC

D. Section 23 09 93 - Sequence of Operation for HVAC and Specification

E. Section 23 34 00 – HVAC Fans

F. Section 23 74 16 – Packaged Rooftop Air Conditioning Units

G. Section 26 05 11 – General Electrical Requirements

H. Section 26 05 20 – Low-Voltage Wires, Cables and Accessories

1.04 REFERENCES

A. Reference Standards:

1. AMCA Air Movement and Control Association Inc.

Standard 500 - Laboratory Methods for Testing Dampers for Rating

2. NFPA National Fire Protection Association

NFPA 70 - National Electrical Code

3. UL Underwriters' Laboratories, Inc.

UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations

B. In addition to the above-mentioned minimum standards, all requirements of; national, state and local codes and regulations; Bureau of Air Resources; Con Edison; DEP; Board of Standards and Appeals and all governing City, State and Federal agencies shall be complied with at no additional cost to the City.

1.05 DESCRIPTION

A. General requirements:

1. In order to centralize responsibility, all control and monitoring items (including field and panel instrumentation, control panels, PLCs, control system hardware and software, software development, etc.) provided under this Contract shall be furnished by the HCS supplier who, through the

Contractor, shall assume complete responsibility for proper installation and operation of the equipment, including that of coordinating all signals, furnishing all appurtenant equipment, and reviewing the conduit and wire system on the Electrical Drawings.

2. Where stated herein, the terms HCS supplier, System Supplier or HVAC I&C supplier shall be read as the Contractor.

3. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, location, installation, activation, checkout, testing, adjustment and proper operation of the entire instrumentation and control system. The Contractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local and central control panels, field instrumentation control systems and related equipment and/or systems and shall provide the services of a qualified installation engineer to supervise all activities required to place the complete instrumentation and control system in stable operation.

4. The Contract Drawings indicate the approximate locations of field instruments and control panels. The Contract Drawings (HVAC and Electrical) also indicate the routing of most major raceways and conduits to interconnect various areas within the building. The Contractor shall examine all the Electrical and Mechanical areas of the Contract Drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract.

5. Contract Drawing shows approximate size of panels. Actual panel sizes can vary from that shown as required to house specific equipment and/or to fit into the space available. The Contractor shall be responsible for the detail design of all panels and enclosures.

6. The terms "Instrumentation" or "Instrumentation and Controls" or "Control System" shall hereinafter be defined as all equipment, labor, services, documents, etc. necessary to meet the intent of the Specifications.

7. Damper or louver motor actuators shown on the Contract Drawings are diagrammatic and show only the requirement for motorized operation. The actual selection, quantity, capacity, layout, connection and sizing of the actuators, as well as linkages and mounting, required for the installation, shall be determined by the HCS Supplier based on the torque required to operate the damper system being provided. In all cases, the maximum torque required shall not exceed 80 percent of the actuator's capability. Larger dampers must be divided into sections. In these cases, multiple actuators are required and shall be furnished and installed complete with all required mounting, linkage, electrical connections, power, control and

disconnecting means. Damper end switches shall be connected to require all sections to open to prove open. The Engineer may allow the series/parallel connection of multiple actuators to provide indication from a majority of units. Dampers shall be configured as fail closed or open as directed by the Engineer.

B. Access:

1. The City shall have the right of access to the HCS Supplier's facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and testing. Office space, supplies and services required for these surveillance activities shall be furnished by the HCS Supplier and the equipment suppliers.

C. Abbreviation:

1. To minimize the number of characters in words used in textual descriptions and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and/or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

D. Alternate Manufacturers:

1. If equipment manufactured by other than those mentioned in the Specifications is selected, the Contractor shall demonstrate that the selected equipment is functionally equal to the specified equipment, dimensionally compatible with space available and equal or superior in quality. The cost of any structural, mechanical, electrical, control, operating, maintenance or design changes necessary to accommodate such equipment shall be borne by the Contractor. Where model numbers for a particular item or equipment are mentioned, they are intended as a standard of quality and capability. It shall be the responsibility of the Contractor to verify items submitted meet the requirements of the Specifications.

E. Analog Signal Transmission:

1. Signal transmission between electric or electronic instruments, controllers and field equipment shall be isolated, linear 4 - 20 milliamperes and shall operate at 24 volts DC (nominal). Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Signals shall be linear with process variable to be measured and displayed. Signal corrections or conversions such as square root extraction shall be performed at the transmitter. All measurement loops shall be grounded at terminals bonded

to the panel ground bus and per the manufacturer's recommendations. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls and appurtenances. Signal isolation shall be provided when interfacing with existing equipment or with equipment supplied by other vendors.

2. Nonstandard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the instrument schedule. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated linear 4 20 milliampere signal proportional to the subject process variable.

F. Environmental Condition:

1. General:

a. Instrumentation equipment shall be suitable for ambient conditions indicated. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment. The HCS Supplier shall be responsible for providing a conditioned power supply for all electrical and electronic equipment furnished under this Contract needing such conditioning.

2. Control/Electrical Equipment Rooms:

a. The above rooms are air conditioned and heated; the temperature will normally be 20 to 25 degree C; relative humidity 40 to 75% without condensation and the air will be essentially free of corrosive contaminants and moisture during normal operation. During periods of abnormal operation, the temperature and humidity will be affected and can revert to outdoor ambient conditions. In addition, in the event of equipment failure, corrosive and contaminating agents will be present.

3. Field Locations:

a. Field equipment including instrumentation located outdoors will be subjected to wind, rain, snow, ice and corrosives in the environment, with ambient temperatures from -20 to 40 degree C and relative humidity from 40 to 100%. All supports, brackets and interconnecting hardware located outdoors shall be type 316 stainless steel. All field instruments mounted outdoors shall be furnished in the specified enclosure and subsequently mounted in thermal insulated field panels fitted with thermostatically controlled space heaters to suit the environment. Refer to Section 23 09 14 – Control Panels, Enclosures and Devices for HVAC for field panel requirements.

4. Process areas:

a. Instruments, control panels, etc. located in process areas such as the Screen Chamber, Injector Room, Fluoride Room, Raw Water Strainer Room, Water Quality Monitoring Room and mechanical equipment rooms, can become exposed to harsh environments with ambient temperatures from 0 to 40 degree C and relative humidity from 40 to 100%. Equipment in these areas shall be corrosion resistant. All mounting hardware supports and brackets shall be made of 316 stainless steel.

5. Electrical Power:

a. The electrical power at the Site is not guaranteed to be without surges, sags, spikes or noise. The Contractor shall provide common mode and normal mode noise reduction, surge suppressors and voltage regulation equipment such as power conditioners, filters, UPS, etc. to assure proper operation of the equipment. The plant power system can be supplied by on Site generators as well as utility power. Frequency swings of +/- 3 Hz and voltage variations of +/- 10% must be tolerated with no detrimental effects, or the equipment must be provided with additional power conditioning.

G.

1.06 QUALITY ASSURANCE

A. It is the purpose of these Contract Documents to secure high quality in all materials and equipment in order to facilitate operations and maintenance of the Plant. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection and during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner.

B. Electronic equipment shall be all solid state construction, utilizing semi-conductors, unless otherwise specified. Components shall be derated to assure dependability and long-term stability.

C. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers or digital controls. All parts shall be indicated in the instruction manuals and shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

D. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of other equal manufacturers when they are favorably reviewed by the Engineer prior to installation.

1.07 SUBMITTALS

A. The Contractor shall submit shop drawings and material specifications for all equipment and Work provided, for the approval of the Engineer.

B. The following is a general listing of Working Drawing requirements for the HCS and associated equipment. When individual Specification Sections contain more specific requirements they shall be considered as additional to these minimum requirements. Components furnished as part of a packaged system shall comply with all requirements herein. All data submitted herein shall be updated to as built condition and appear in the final O&M manual. As a minimum, submittals shall include:

1. General (applies to all equipment and services supplied)
    a. Catalog cuts and data sheets.
    b. Installation and mounting details, methods and manuals with manufacturer's recommendations.
    c. Operation and users manuals.
    d. Reference manuals for hardware and software.
    e. Schematic wiring diagrams.
    f. Interconnection wiring diagrams.
    g. Location and mounting details.
    h. Space and power requirements.
    i. Enclosure / housing information.
    j. Materials of construction and finish data for all components.
    k. Bill of materials including quantities and model numbers.
    l. A list of spare parts and special tools.
    m. O&M manual.
    n. A listing of available and provided options and features.
2. Field and panel instruments:
    a. Completed ISA data sheets including manufacturer's name, model number, instrument tag number and serial number.
    b. Sizing, orientation and location calculations.
    c. Description of construction features.
    d. Performance, configuration and operational data.
    e. Service and maintenance requirements.
    f. Range, size and graduations.

g. Instrument or control device sizing and location calculations, where applicable.

h. Configuration data for all programmable instruments.

3. Control panels and control room:

a. Front, rear, top, bottom and side views showing access panels and all external features.

b. Assembly drawings.

c. Front panel instrument layout, legends, name plates and annunciator engraving listing.

d. Panel sections showing the location of all back of panel mounted instruments, power supplies fuses, relays, PLCs, terminal blocks, etc.

e. Power and grounding requirements, electrical schematics, point to point internal panel wiring and terminal block arrangement and numbering.

f. Contact development diagrams for all instruments, controls, relays and switches.

g. Ventilation / cooling methods and heat rejection calculations.

h. Color samples for panels.

i. Control room equipment layout and interconnection diagrams.

j. Conduit entry diagram.

k. Working drawings for all included equipment.

4. Programmable logic controller drawings.

a. Complete, well-annotated ladder logic and I/O listing.

b. Cross reference and variable tables and listing within ladder.

c. Physical rack and equipment layout drawings.

d. Communication and network diagrams and addressing schemes.

e. Hardware and software user, maintenance and installation manuals.

5. Electrical equipment, conduit and wiring layout drawings.

6. Factory and field test procedures, sample reports and certified reports.

C. Drawings:

1. Shop Drawings:

a. The HVAC drawings, electrical drawings, approved equipment shop drawings and instrument installation details shall govern the detailed layout of the completed construction.

1) Locations of field instruments are approximate. The Contractor shall be responsible for field verification, final placement and orientation of instruments to assure optimum performance, proper connection to the process and the instrumentation and control system and unrestricted access for maintenance and observation.

2) Not all field instruments are located on the Contract Drawings. Contractor shall follow the general guidelines established in the specification and best standard industry practice to determine the location of such instruments.

2. As-Built Drawings:

a. The Contractor shall maintain a complete and accurate record set of Drawings for the instrumentation and control system construction work. All Work shall be recorded.

D. Catalog Cuts:

1. The Contractor shall submit for review and approval; the name of the manufacturer; identifying trade name and/or model designation; data sheets; instruction, operation and maintenance manuals and catalog cuts for all equipment, material and software provided under this Division. Catalog cuts shall be certified for the tag numbers and ratings of the equipment being supplied. The model selected and all options selected shall be highlighted. The Contract tag numbers for all typical units shall be included in the submittal.

E. Electrical equipment, conduit, wiring, etc. submittals

1. Submit complete conduit and wiring layout drawings associated with the HCS. Submit Shop Drawings for all electrical work and materials in accordance with Section 26 05 11 – General Electrical Requirements, Section 26 05 20 – Low-Voltage Wires, Cables and Accessories.

F. Configuration Data Sheets:

1. For all PLCs, I/O blocks and programmable and/or “smart” programmable instruments, complete configuration data shall be submitted. All configuration and programming shall also be provided in appropriate storage platform. Configuration software shall be used to develop when available.

G. Documentation:

1. If any documentation or other technical information submitted is considered proprietary, such information shall be designated. Documentation or technical information which is designated as being proprietary shall be provided and will be used only for the construction, operation, or maintenance of the system and, to the extent permitted by law, will not be published or otherwise disclosed.

   a. Operating and Maintenance Manuals.

      1) The Contractor shall submit operations and maintenance manuals in accordance with the procedures and requirements set forth in Specification Section 01 78 25 – Operations and Maintenance Manuals.

      2) Preliminary O&M manuals shall be included in the shop drawing submittal. Without inclusion of these manuals, the submittal will be considered incomplete and will be returned without review.

      3) Original manufacturer's manuals and drawings shall be provided for all equipment and services provided under this Contract. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, loop diagrams and instructions necessary for installing, operating and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data and full preventative maintenance schedules.

      4) The instructions shall be bound in binders with drawings reduced or folded for inclusion and shall provide at least the following as a minimum:

         a) A comprehensive index.

b) A complete "As-built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.

c) A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

d) Full Specifications on each item.

e) Detailed service, maintenance and operation instructions for each item supplied.

f) Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

g) The operating instructions shall also incorporate a functional description of the entire system, with references to drawings and instructions.

h) Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

i) The operating manual shall be bound in one or more separate volumes from the maintenance manual and shall include detailed instructions which clearly describe the step-by-step procedures which must be followed to implement all phases of all operating modes. The contents of this manual shall be in terms understandable and usable by operating personnel. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

j) The maintenance manual shall be bound in one or more separate volumes and shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. Within the complete Hardware Maintenance Documentation, all hardware maintenance manuals shall make reference to appropriate diagnostics, where applicable, and all necessary timing diagrams, component drawings and PCB schematic drawings shall be included.

k) The Hardware Maintenance Documentation shall include, as a minimum, the following information:

(1) Operation Information. This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

(2) Preventive Maintenance Instructions. These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.

(3) Corrective Maintenance Instructions. These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.

(4) Parts Information – This information shall include the identification of each replaceable or field-repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between equipment numbers and manufacturer's part numbers shall be provided.

b. Application Software for PLC:

1) The Contractor shall provide 5 copies of a software documentation book which contains programs developed for this Project with extensive annotation of all logic.

2) All information associated with each application software program shall be assembled into a program description which will contain a detailed text that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This

descriptive text shall be written in a language that is understandable by non-software oriented readers.

H. Qualification Submittal:

1. The Contractor's HCS Supplier shall comply with all requirements stated herein.

2. The HCS Supplier shall be a qualified contractor having 5 years experience in providing DDC based major HVAC control and monitoring systems. The Contractor shall submit a detailed statement of recent experience in the completion of instrumentation, control, and information systems similar in type, size and complexity to that proposed for this Project. The statement shall include his last five projects completed to demonstrate the necessary experience required to perform work for the Project.

3. No later than 20 Days after notification to proceed, the Contractor shall submit to the Engineer the following information for approval of the HCS Supplier:

   a. General performance history of the prospective HCS Supplier, including:

      1) Wastewater treatment plant experience.

      2) Last five projects completed as additional proof of the necessary experience required.

      3) Detailed statement of recent experience in the completion of instrumentation, control and information systems similar in type, size and complexity to that proposed for this Project.

         a) The statement of experience shall provide a detailed description of each above referenced system including:

            (1) Name and address of owners and their representative(s).

            (2) Block diagram.

            (3) Functional description.

            (4) Project location.

            (5) Date of installation.

            (6) Date placed in operation.

4. A clear statement describing any and all deviations from the system specified herein, together with reasons for said deviations.

5. Resumes of proposed project engineer, project manager and field engineers.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Special care shall be exercised during delivery, distribution and storage of the materials to prevent damage. As a minimum, all equipment shall be stored per the manufacturer's recommendations. Damaged or incorrectly stored materials will be rejected and shall be replaced at the Contractor's expense. The storage area shall be ventilated and temperature controlled and the air shall be filtered and free of corrosive contaminants and moisture

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools for all equipment supplied, in accordance with Section 01 78 24 – Spare Parts and Maintenance Materials, and as detailed herein. Deliver all spare parts, tools and supplies with the equipment, neatly wrapped and boxed, indexed and tagged with complete information on their use and reordering.

B. The Contractor shall provide an inventory of spare parts for all control and instrumentation equipment provided as recommended by the manufacturer, as indicated below and in accordance with the individual Specifications.

C. Expendable Spares:

1. The Contractor shall provide expendable spares as needed or as required by the City during startup and testing and the specified warranty period. Expendable spares include items such as recorder and printer paper, fuses, ink, ribbon, lamps, etc. Expendable and non-expendable spares used during startup, testing and/or the warranty period shall be replaced by the Contractor. Based on the quantities used during the startup and warranty period, a one-year supply of all items shall be furnished at the end of the Contract.

D. Non-Expendable Spares:

1. As a minimum, the Contractor shall provide the following non-expendable spare parts. All equipment shall be burned in, tested and ready for use. These quantities are minimums, when more stringent requirements are made in other Sections, they shall supersede those indicated herein.

a. 10% (minimum of 1) circuit boards or modules of each type used in electronic field and/or panel instrumentation.

b. 10% (minimum of 1) instruments, devices and elements of each type.

c. 10% (minimum 2) of each type and rating of circuit boards (or modules) (I/O modules communication modules, network equipment, power supply module, etc.) used in the PLC system.

d. 10% (minimum of 2) adapters, converters, etc used in PLC and instrumentation systems.

e. 10% (minimum of 2) CPU and rack for each type used in PLC equipment.

f. Additional spare parts as recommended by manufacturer for each instrument.

g. 10% (minimum of 10) pilot, graphic and annunciator light bulb/led of each type.

h. 10% (minimum of 10) spare fuses of each type and rating provided.

i. All non-expendable spares consumed during installation, testing, start-up and the warranty period, shall be replaced by the Contractor prior to Final Acceptance of the system by the City. A list of spare parts for each instrument shall be submitted with the shop drawing for that instrument.

E. Special Tools:

1. Special tools, test equipment and software shall be provided for testing, checking, calibrating, configuring, programming, trouble shooting and repair of all equipment and services provided under this Section. All equipment provided herein shall be supplied with items such as instruction and operating manuals, manufacturers standard carrying/storage cases, unit battery charger and spare battery. Special tools, calibration fixtures, cord extenders, patch cords, power supplies, test leads, etc. as necessary, shall be provided for all equipment provided herein. All meters, test and calibration equipment shall be furnished with an NIST Traceable certificate of calibration. Certification shall be no more than 6 months old when equipment is turned over to the City.

2. The Contractor shall provide factory authorized training for DEP personnel on all special tools and test equipment and software provided.

3. As a minimum, the Contractor shall provide the following special tools:

a. Dry block calibrator capable of ambient up to 1100 degrees F with inserts for 1/8 inch -1/2 inch thermal sensors and NIST certificate, JOFRA Model 4070T, or approved equal.

b. Beta temperature calibrator Model 4610T, or approved equal, with pressure modules to simulate and measure 0 – 100 inch W.C. and 0 – 300 psig.

c. Two Fluke 87 III true RMS multi meters with 200 amp AC/DC current probes and hard cases, or approved equal.

d. Portable Calibrators:

1) Portable calibrators shall be capable of measuring DC volts, mV, mA, ohms, frequency, T/C, peak detect and trip detect

on its input and simultaneously generate on its output all of the preceding signals plus two-wire simulation, ramp functions, up/down stepping and 10 point programmability. Each calibrator shall be furnished complete with 24 Vdc integral battery pack 120 VAC power adapter, spare battery pack, test leads, external charger, fuse pack, carrying case and appurtenances. Basic accuracy for DC voltages and currents shall be +/- 0.025%; Resistance: +/- 0.035% for input and +/- 0.05% for output; Frequency: +/- 0.01%. Two portable calibrators shall be furnished. NIST traceable Certificates of Calibration shall be furnished for all calibrators. Calibrators shall be Rochester Instrument System AccuPro Diamond Plus, BETA, Transmation, or approved equal.

e. Portable Gauge and Differential Pressure Calibrator

1) Furnish one portable microprocessor-based, with 8K of memory gage and differential pressure calibration system. The calibration system shall include the following items: integral 115 VAC/DC battery power supply with charger, battery indicator and two sets of NI-CAD batteries 2; pump modules (0-100 psig max air type and 0-500 psi max hydraulic type psi max) with coarse and fine adjustment; and four pressure modules (0-10 inches W.C., 0-30 psi, 0-100 psi, 0-300 psi). All accessories, including manuals, tubing connectors and appurtenances shall be furnished for the unit, complete with weather resistant carrying case. Calibration systems shall be BETA Model 320 (Dual Sensor) as manufactured by BETA Products or approved equal.

f. Oscilloscope

1) One Electronic Oscilloscope with utility cart for field use equal to Tektronix type 465 with dual trace and rechargeable batteries or Hewlett-Packard Co. Model 1222A, or approved equal.

2) A utility cart shall be provided constructed of rugged structural foam and include two shelves each with 150 lbs capacity, 4 swivel casters with 4 inch wheels. Cart shall be as manufactured by JENSEN Model 997B001, or approved equal.

g. Hand Tools

1) A complete set of standard hand tools shall be furnished with the equipment. The set shall include approximately 100

tools and shall be supplied in a durable aluminum case. The tool kit shall be model JTK-17A by Jensen Tool of Phoenix, AZ, or approved equal.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Identification:

1. The system described below applies to all instruments and controls provided for this Project. Instruments not shown on the Contract Drawings but supplied by the Contractor to meet the functional requirements will be tagged as follows.

2. Instrument symbols and letter designations shall generally be in accordance with ISA Standard ISA-S5.1.

3. Instrument numbering shall be as follows:

a. Example: XXXX-YYY-FIT-###

1) XXXX - Building or Area Code Number

2) YYY - Equipment or Panel Number

3) FT - Instrument Designation (ISA)

4) ### - Sequential Process Loop Number

4. Instruments furnished as part of mechanical equipment and package units shall be identified and tagged with a unique number in the same manner under this Section. Tag names shall be submitted for approval. All the drawings and manuals pertaining to an instrument shall carry the full instrument identification tag number.

B. Nameplates:

1. All equipment, instruments, controls, panels, enclosures, network hardware, workstations, etc., shall be identified with nameplates. Equipment Tag names are for construction purposes. A list of final Tag names shall be provided by the City for final identification purposes and engraving. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number, full tag numbers and description of the item and function. Network node identifiers and applicable addresses shall be included for all computer based equipment. Abbreviations of the description and function shall be subject to the Engineer's approval. The Contractor shall furnish and install an additional one-hundred nameplates of the applicable type, 3 inch by 8 inch with three lines of 3/8 inch engravings per the Engineers instructions.

2. Temporary printed and laminated tags shall be affixed to all equipment until permanent tags are installed.

3. Nameplates shall be made of 1/16 inch thick machine engraved laminated phenolic plastic having black characters not less than ¼ inch high on a white background. Minimum size for name plates shall be 1 inch x 3 inches. All field mounted instruments shall also have SS name plates, which shall indicate the Contract tag number and service for that instrument. Additionally, each instrument shall have an engraved nameplate mounted adjacent to it indicating tag number, system, subsystem, manufacturer, range, setpoint, etc. All control panels and enclosures shall have nameplates with the equipment identifier and pertinent data. A second tag light blue with ¼ inch white lettering shall indicate network name and addresses and node names, etc. Engravings shall be submitted for review and approval.

4. Nameplates shall be attached to metal equipment by SS screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled (where applicable) and attached to the associated device by means of a braided stainless steel lanyard.

C. Finishes:

1. All instrumentation and control system materials and equipment which do not require a corrosion resistant finish or do not have an approved factory coating, shall be factory painted in accordance with Section 09 91 00 – Painting. All paint finishes shall include proper surface preparation, prime coat and a final finish coat. Any final finish which has been damaged or is otherwise unsatisfactory shall be repaired and be in good condition at the time of Final Acceptance.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. All equipment provided under this Contract shall be of the highest quality, state of the art, currently manufactured equipment offered as standard production items by nationally recognized and reliable firms. Untested or custom, one of a kind or experimental items or services shall not be permitted. Equipment provided under this Contract shall be heavy duty, industrial quality and designed for use in harsh industrial environments.

B. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Field-mounted devices shall be rugged and securely mounted on walls or pipe stands or as indicated in the Contract Documents.

C. All printed circuit boards utilized in instruments shall be cleaned, baked and coated with polyurethane or polyethylene conformal, or epoxy coating to immunize against effects of moisture, vibration and corrosive agents.

D. Panel-mounted devices shall be heavy duty oil tight type 30.5 mm with a rating equal to or greater than that of the enclosure.

E. All equipment provided under this Contract shall return to accurate measurement and operational condition upon restoration of power after a power failure or momentary interruption.

F. During periods of utility power outages, the Site will be powered by on-site emergency generators. Additionally, frequent plant load testing of emergency generators will be performed. At these times, equipment provided under this Contract will be powered by the generators. Voltage dips and spikes as well as frequency variations are to be expected during these periods. All equipment provided herein shall be capable of operation on emergency generator systems. The Contractor shall provide appropriate power conditioning for any equipment found to experience problems associated with the generated power.

G. The use of any device, instrument, equipment, etc. containing mercury shall be prohibited.

H. Power Supplies and Circuit Protection:

1. All equipment, instruments and devices provided under this Contract, requiring electrical power, shall operate on a nominal 120 Vac or 24 Vdc as indicated. 120 Vac power feeds for all instrument and control equipment

shall be provided under Section 26 05 11 – General Electrical Requirements, Section 26 05 20 – Low-Voltage Wires, Cables and Accessories.

2. Alternating current power supplies to panel mounted equipment shall be through a main circuit breaker and branch breakers or fuses located inside the panel. All 24 Vdc transmitters shall be powered from power supplies within the panel. Power supplies shall be redundant using a voting system or blocking diodes for isolation. Alarms shall be provided for each supply bus. All 24-volt instrument, signal and control circuits shall be individually protected by draw-out fuses, located in the panel.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. All equipment shall be installed per the Contract Documents, manufacturer's recommendations and standard industry practice. When installation methods are not shown or specified, the manufacturer's recommendations shall be used after review and approval by the Engineer. All mounting and supporting hardware and appurtenances shall be furnished and installed under this Contract.

B. All equipment shall be securely and rigidly mounted. Equipment shall be mounted in locations approved by the Engineer and out of the way of potential damage. Items shall be installed so as to provide ease of maintenance and operation. Equipment shall not be installed where it impedes access or egress within an area. In addition, the installation shall not block or impede maintenance or operational access to other equipment.

C. Instruments and indicators shall be installed to allow the operator or service personnel to read the device while at the local control location of the associated equipment. When no local control location is provided, a central location at the equipment shall be chosen by the Engineer. All indicators and readouts shall be located so as to be readable from that area and the process floor.

3.03 FIELD TESTING / QUALITY CONTROL

A. All equipment shall be tested in accordance with Section 23 09 15 - Instrumentation and Controls Systems Testing, Installation and Start-up for HVAC.

3.04 STARTUP / DEMONSTRATION

A. General:

1. To familiarize the City's personnel with the HCS, field instrumentation and the HVAC process control system, training shall be provided on all

equipment and services provided under this Contract, as indicated in the Specifications, and as specified herein. All costs of providing the training courses shall be borne by the Contractor. All training courses shall be conducted under the direction of a training director who shall design a detailed training plan that complements the experience and skill levels of the City's personnel. All training shall be completed prior to or immediately after system startup. All training activities conducted shall meet the requirements of Specification 01 79 05 – Equipment Start-up and Training . As a minimum, training shall be provided for the following:

a. PLCs including basic ladder programing, documentation, etc.

b. Project specific PLC application programs.

c. Control panels and their operation.

d. All instruments, controllers, elements, controls, etc.

e. Control Strategies.

f. HVAC equipment and system operation from control system

2. Training Aids:

a. The manufacturer’s instructors shall incorporate training aids as appropriate to assist in the instruction. At a minimum, the training aids shall include text and figure handouts. The manufacturer shall turn over all the training aids to the City. Other appropriate training aids are:

1) Audio-Visual aids (e.g., films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, catalogue sheets).

2) Equipment cutaways and samples (e.g., spare parts, damaged equipment).

3) Tools (e.g., repair tools, customized tools, measuring and calibrating instruments).

b. The manufacturer’s instructors shall utilize descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts shall accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are encouraged. Handouts planned for the instruction shall be attached with the manufacturer's proposed Lesson Plans.

3. "Hands-On" Demonstrations:

a. The manufacturer’s instructors shall present "hands-on" demonstrations of common corrective maintenance repairs and

troubleshooting of common problems associated with all installed equipment. Two presentations for mechanical repairs and two involving electrical repairs will be made for each. The manufacturer shall provide the tools and equipment to conduct the demonstrations and calibration units as needed. Requests for supplemental assistance and facilities should be submitted with the manufacturer's proposed Lesson Plans. The proposed "hands-on" demonstrations shall be described in the manufacturer's proposed Lesson Plans and shall be specific for equipment installed.

b. In any "hands-on" training situation where City's operations or maintenance personnel participate in disassembly or assembly equipment components, the manufacturer shall be responsible for such disassembly or assembly and shall provide written certification of proper equipment operation to the City.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall, through the services of the Heating and Ventilating Control Systems Supplier (HCS Supplier), furnish, install, test and place in operation, HVAC process instrumentation and control devices, as detailed herein and as shown on the Contract Drawings. The instruments and controls shall be top quality, standard offerings of a nationally recognized manufacturer. When available, instruments and/or control devices shall be procured from a single manufacturer. The equipment shall be installed in accordance with the Specifications, manufacturer's recommendations and best industry practice. Instruments and controls shall be installed complete with all process connections, supports, mounting brackets and hardware, conduit and wiring, terminations, etc. to provide a complete and properly functioning installation.

B. The following index of this Section is presented for convenience:

C.

D. The Contractor shall provide all necessary process taps, isolation valves, nipples, penetrations, instrumentation supports, etc. required to provide a complete and operational installation. Conduits, raceways, wiring, junctions for control and signal wiring shown on the Contract Drawings and as required for a complete installation shall be provided under this Contract.

E. Taps and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the sizing, location, orientation and dimensions of instruments and the connections and taps for instrumentation furnished under this Division are such as to provide the required accuracy of measurement, the proper bracing, and protection of the sensor from accidental damage and accessibility for maintenance.

F. It shall be the responsibility of the HCS Supplier to provide instruments that have been properly sized and applied to the process in which they are to be used. The HCS Supplier shall calculate the proper size, range, material, location, orientation and set point for all instruments provided under his Contract to give the most accurate readings in the appropriate ranges. Calculations shall be submitted with the instrument for approval. Unless otherwise noted, instruments shall be selected so that the expected nominal operating range is within the middle 1/3 of the instrument’s scale.

G. All instrument taps shall be provided with isolation valves or thermo-wells to permit testing, calibration and replacement without shutdown of process or system. A test port and block valve for in-place calibration shall be installed for each instrument.

H. As part of his testing, the Contractor shall assume the responsibility of testing of all electrical work associated with this system.

I. The Contractor shall furnish and install supply and return pressure gauges and thermometers as specified herein at all points indicated on Contract Drawings, where piping enters or leaves all buildings (or areas of buildings, elevations) and where piping attaches to equipment. In addition, pressure gauges shall be provided on both sides of all pumps, pressure control valves, regulators, strainers, filters and points of attachment to other and existing plant services as well as

J. Instruments and controls shall be correctly interfaced to the system and equipment to which they are associated and connected. Mounting brackets and/or stands, hardware, anchors and appurtenances shall be furnished and installed as required.

K. Instruments shall be installed in logical groups associated with a specific piece of equipment or system and shall be readable from a central location near the associated equipment. Instruments shall be oriented so as to be easily readable from the floor.

L. In addition to those shown on the Contract drawings, the Contractor shall furnish and install thermometers and pressure gauges as described herein at the following locations.

1. Inlet and outlet of all heating and cooling coils, AHUs, ACs, HVs, etc.
2. Inlet and outlet of all heat exchangers
3. All common supply and return headers
4. Supply and return branch connections to heating zones
5. Supply and return branches in each area
6. Supply and return piping when penetrating floors and between areas and buildings

M. In addition to those shown on the Contract drawings, the Contractor shall furnish and install pressure gauges as described herein at the following locations.

1. All water headers
2. Before and after all pressure regulators and reducing stations
3. On both sides of strainers and filters
4. At all feed points and connections between disciplines and systems

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 09 00 – Instrumentation and Controls Scope and General Requirements for HVAC

B. Section 23 09 15 – Instrumentation and Controls system Testing, Installation and Startup for HVAC

C. 23 09 14 – Control panels Enclosures and Devices for HVAC

D. 22 05 23.12 – Ball Valves for Plumbing Piping

E. 22 05 23.14 – Check Valves for Plumbing Piping

1.04 REFERENCES

A. All equipment and services provided herein shall be in accordance with the references stated in Section 23 09 00 – Instrumentation and Controls Scope and General Requirements for HVAC.

B. Reference Standards:

1. ASTM American Society for Testing and Materials Standard A774 As-Welded Wrought Austenitic Stainless-Steel Fittings for General Corrosive Service at Low and Moderate Temperature, Standard A269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service
2. SAMA Scientific Apparatus Makers Association, Standard RC17-10-1963 - Bushings and Wells for Temperature Sensing Elements

1.05 DESCRIPTION

A. Instrumentation/controls specifically identified in the Contract Drawings as being furnished with mechanical equipment shall be furnished and installed by the vendor or as specified elsewhere in the Contract Documents but will be calibrated and tested under this Section for proper operation and interface with the HCS.

B. Electrical conduit and wire specifically shown on the electrical Contract Drawings.

C. Signals:

1. All electronic instruments (transmitters) shall provide a linear 4 to 20 milliamp signal at a nominal 24VDC. The signal shall be proportional to the process variable indicated. Signal conditioning (such as square root extraction or frequency conversion), if needed, shall be done by the transmitter electronics.
2. All electronic devices (when available) shall be the microprocessor based "smart" type. Milliamp signals (4 - 20mAdc) shall have a superimposed Hart digital signal which will allow for remote communication with these devices. Handheld programmers shall be provided.
3. Discrete switch closure contacts shall use nominal 120 VAC control voltage. 24 Vdc discrete contact closures shall be used where indicated. All devices shall be rated for 120 Vac as a minimum. Contact rating shall be 2 amp minimum unless otherwise noted.

D. Units:

1. Units shall be as follows:
2. VARIABLE UNITS
3. Temperature Degree F
4. Pressure
5. - Below atmospheric Inches of Hg Absolute
6. - Near but below Atmospheric Inches of Water
7. - Above Atmospheric PSIG
8. - Absolute PSIA or Inches of Hg Absolute

9.	Level	0 to linear feet or quantity
10.	Flow	
11.	- Liquids	GPM. @ 60 degrees F
12.	- Gas or Vapor	SCFM @ 60 degrees F and 14.7 PSIA
13.	Relative Humidity	0-100%
14.	Capacity	0-100%
15.	Heating Load	BTUs
16.		

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for all equipment and work provided, for the approval of the Engineer.

B. Submittals shall include, but not be limited to:

1. Completed ISA S20 data sheets, installation and instruction manuals, operation and maintenance manuals, for each and all items provided under this Section, for review and approval. Each item's data sheet shall have a complete listing of tag numbers to which that data pertains.
2. Manufacturer's installation, operation and maintenance manuals.
3. Software, manuals and configuration data for all units requiring programming and/or configuration.
4. Shop Drawings and descriptions of supports, mounting details and process connections and taps for all instruments.
5. Calculations, assumptions and manufacturers recommended installation requirements indicating the methods used in proper sizing, location and orientation of all instruments.
6. Instrument installation layout drawings showing proposed locations of all instruments and equipment. The drawings shall be done to scale and dimensioned on a background of equipment and piping.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Deliver all spare parts, tools and supplies with the equipment, neatly wrapped and boxed, indexed and tagged with complete information on their use and reordering.

B. Provide all of the individual manufacturers recommended spare parts and tools for all equipment specified herein. In addition to the recommended spares, furnish all of the following minimum spare parts, tools and devices:

1. General

   a. 10% (minimum of 10) spare fuses, indicating lights, etc., for each size and type provided.

2. Electronic Field Instruments

   a. One complete spare instrument of each type for every 10, or part thereof furnished (minimum of 2). Included shall be any integral indicators, adapters, converters and modules needed to provide a complete functional replacement. Where similar units have been provided having different characteristics or ranges, the aforementioned quantities shall pertain to each type. Where instruments of the same type having different ranges are provided and the unit can be rescaled by field adjustment, the quantities listed shall apply to the total number provided.

3. Primary Sensing Elements

   a. One spare of each size and type, complete with housing and appurtenances for each 10 or part thereof installed (Minimum of 1).

4. Pressure and Temperature Switches

   a. One spare of each size, type and range, complete with housing and appurtenances for each 5 or part thereof installed (Minimum of 2).

5. Panel Mounted Instruments

   a. (Includes Loop Controllers, Digital Indicators, Run Time Meters, Isolators, converters, etc.)

   b. One spare of each size, type and range, complete with housing and appurtenances for each 10 or part thereof installed (Minimum of 2).

   c. In addition to the spares required above, the Contractor shall provide:

      1) One spare power supply for every 5 or part thereof installed (Minimum of 2).

      2) One spare electronic module, indicator and/or circuit board for every 5 or part thereof installed (Minimum of 1).

      3) One complete set of memory modules for each controller installed with the current program preloaded.

6. Non-Electronic Gauges, Indicators, Thermometers, etc.

a. One spare gauge or indicator of each size, type and range, complete with appurtenances (diaphragms, snubbers, thermo-wells, capillaries, etc.) for each 10 or part thereof installed. All units shall be tested, certified and ready for use. Units with diaphragm seals, remote capillaries, etc., shall be filled, tested as a unit and ready for use.

b. One spare isolation/calibration valve of each size and type for each 20 installed. (Minimum of 1).

c. One spare appurtenant device (snubbers, manifolds, diaphragms, etc.) of each size and type for each 10 installed. (Minimum of 1).

7. Valves

a. Provide 1 valve body packing and rebuild kit of the correct type with each 10 valves provided or part thereof.

b. Provide 1 spare valve of each size and type for each 5 or part thereof installed.

8. Actuators

a. Provide 1 spare actuator of each size, type and rating (valve and damper, two position and modulating) for each 5 or part thereof installed.

9. Fuses

a. Provide 10% spare fuses (minimum of 10) for each type and rating used in field and panel instrumentation. (Including test equipment).

C. Tools:

1. Special tools required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance shall be provided (i.e., connector pin insertion and removal tools, wire crimping tool, special wrenches, special instrument calibrators/configurators, indicator lamp insertion and removal tools, etc.).

2. The Contractor shall furnish all tools and test equipment, complete with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for field testing or maintaining equipment supplied under this Contract.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Refer to section 2.02

2.02 MATERIALS / EQUIPMENT

A. Pressure Indicators

1. Pressure Gauges

a. The Contractor shall furnish and install pressure gauges as stated herein.

1) When gauges are to be mounted with a centerline height between 10 feet to 12 feet above finished floor, the gauge dial diameter shall be 8 inches. As an alternative, 4½ inch gauges may be wall or stand mounted at eye level and tubing run to the process connection.

2) Isolation valves shall be provided both at the process connection and at the instrument.

3) Pressure connections shall be 1/2 inch NPT with isolation and test valves provided.

2. Differential Pressure Indicators

a. The Contractor shall furnish and install differential pressure indicators (gauges) as indicated for pressure gauges above, and as specified herein.

1) Element type: Bourdon tube gauge assembly encapsulated in a pressure chamber shall be used for differential pressure measurement above 10 psig. For measurement of differential pressure below 10 psig multiple diaphragm assembly supported on bulkhead plate housed in pressure chamber shall generally be used.

2) Element material: Material for measuring element shall generally be stainless steel as a minimum. Gauges used for air service may be Berillium or Phosphor Bronze, or approved equal.

3) Operation: Piston operated differential gauges shall be considered as an alternate to measure pressure drop across filters, valves and equipment.

4) Manufacturers: Indicators shall be as manufactured by Weiss, Ashcroft, Dwyer, or approved equal.

5) Indicators used to indicate flow shall have their dial calibrated in flow units. Flow measurement gauges shall be installed with air venting valves, blow down valves, and a balancing valve for zeroing.

B. Pressure and Differential Pressure Instruments

1. Pressure and Differential Pressure Switches

a. The Contractor shall furnish and install pressure and differential pressure switches and as specified herein.

1) Element: Low pressure draft and water column range units shall use slack diaphragm elements.

2) Adjusting Mechanism: Pressure setting values for the range specified shall be indicated on a pressure setting scale. The normal operating range shall be within the middle one-third of the total scale.

3) Dead band: Pressure adjustments shall include an adjustable dead band.

4) Accuracy: +/- 1% of scale.

5) Electrical connections: Electrical connections to the switch unit shall be by terminal lugs. In lieu of terminal lugs, a minimum of 19 inch free leads are acceptable for explosion-proof model only. In this case, the leads shall be hermetically sealed, where leaving the switch housing and the seal must be listed by FM and/or UL. When lead type connections are furnished, a separate junction box shall be provided, connected to the switch with flexible conduit and installed. The unit and included box shall comply with all requirements of Division 16 and all area classifications.

6) Pulsation Dampeners: Pulsation dampeners shall be provided for all pressures instruments subject to sudden pressure surges and/or pressure fluctuations, e.g., pump discharge. Pulsation Dampeners shall have 1/2 inch NPTM switch connection and 1/2 inch NPTF process connection. Pulsation dampener material shall generally be 316 SS as a minimum. Pulsation dampeners shall be selected from, multiple hole, piston and filter type, etc., depending upon process fluid, pressure and temperature requirements.

7) Over range protection: Pressure switches shall be designed to withstand inadvertent application of pressure equal to 1.5 times full scale pressure as a minimum.

8) Manufacturer: SOR, Ashcroft or approved equal for high and medium pressure service and Dwyer, Preferred, or approved equal for low pressure service.

2. Pressure and Differential Pressure Transmitters

a. The Contractor shall furnish and install pressure and differential pressure transmitters as specified herein.

1) Process connection: Process connections shall be 1/2 inch NPTF. Transmitter body shall be provided with drain plug and vent valves. Valve and plug material shall be type 316 stainless steel as a minimum. All differential pressure transmitters shall be provided with a 3-valve calibration manifold.

2) Adjustments: All zero and span adjustments shall be non-interacting. Transmitter output shall be 4 to 20 maDC proportional to measured variable i.e. differential pressure transmitters used for flow measurement shall have their indicators and outputs linearized to flow.

3) Zero adjustment: Zero elevation and suppression shall be built in to the standard transmitter and be adjustable over a range equivalent to a minimum of 50% of calibrated span.

4) Transmitters used for flow measurement (with annubar, venturi, etc.) shall be temperature compensated multivariable type. Units shall be Rosemount 3059 MV or approved equal. Furnish and install temperature element as specified herein. Conduit and wire between element and transmitter shall be provided under this Contract.

5) Remarks: Transmitters used for gas service shall be approved for the application. Installation of such units shall comply with all codes and regulations.

C. Flow Instruments

1. Positive displacement water flow meters/totalizers

a. The Contractor shall furnish and install water flow meters as stated herein. Provide positive displacement flow elements and transmitters where required by the Contract Documents.

1) Function: Indicate and transmit flow rate and totalization data of system makeup water.

2) Type: Compound flow meter utilizing disk type element for low flow conditions and turbine type element for high flow conditions.

3) Material: Case & cover, water works bronze 75% copper; case bolts, type 316 stainless steel; turbine spindles, Tungsten carbide or stainless steel.

4) Elements: AWWA class II dual suspension turbine and nutating disk.

5) Size: 2 inch.

6) Operating Pressure: 175 psi.

7) Operating Temperature: 250 degrees F.

8) Flow rate: nominal: 1/2 to 160 gpm

9) Max: 200 gpm

10) Max head loss @ full flow: 7 psi.

11) Display: Direct reading magnetic drive registers with low flow indicator. Units shall be US gpm.

12) Transmitter: Pulsed output proportional to flow rate. A signal conditioner shall be provided to convert to 4 - 20ma flow signal. Integration (totalization) shall be performed in the main PLC for display and reporting by HCS.

13) Calibration: Cover mounted stainless steel calibration vane.

14) Accessories: Provide full size manufacturers recommended plate type upstream strainer.

15) Manufacturer: AMCO, Dwyer or approved equal.

16) Model: C3000 Compound Meter.

17) Meter shall be installed horizontally at a maximum height of 4 feet above finished floor and shall be easily accessible and readable.

D. Temperature Indicators

1. Temperature Gauges (Thermometers)

a. The Contractor shall furnish and install temperature indicators as stated herein.

1) Function: Indication of temperature.

2) Type: Industrial mounted bimetallic or gas filled (when required) type dial thermometer.

3) Case: hermetically sealed stainless steel case and bezel. The unit with glass shall be moisture proof.

4) Glass: Heavy duty polycarbonate or shatterproof glass, gasketed to bezel and case.

5) Dial: Heavy gauge aluminum, 5 inch, white matt finish with black graduations and numerals, 270 degree readable dial scale.

6) Accuracy: +/- 1% of scale range.

7) Mounting: Minimum of 1/2 inch stainless steel NPT male thread and 1/4 inch diameter stem, 180 degree variable angle dial head and 360 degree dial face rotation. Stem length ("U" dimension) shall be sized to place the stem tip in the center of the vessel or pipeline. Stainless steel 3/4 inch (minimum) NPT male thermo-wells of the proper length shall be provided for all units.

8) Vibration: Where subject to vibration units shall be furnished with silicone liquid filling. Where subject to severe vibration or where mounting height would be above 12 feet, remote mount, gas actuated units with capillary tubing as required shall be provided.

9) Capillary: Where required by height or vibration restrictions (as above), shall be stainless steel tubing with interlocking stainless steel armor over the entire length.

10) Adjustments: Units shall have external recalibration means.

11) Manufacturers: Thermometers shall be as manufactured by Weiss Instruments Inc., Ashcroft, or Trerice, or approved equal.

E. Temperature Instruments:

1. Temperature Indicating Transmitters

a. The Contractor shall furnish and install temperature elements and transmitters as specified herein.

b. The transmitter shall be separate from the element and shall be stand or wall mounted at 5 feet above finished floor. Elements shall be spring loaded, three wire, 0.385 alpha, 100 ohm platinum RTDs with dual elements (one spare). Conduit and cable shall be provided between the units under this Contract as required.

c. 3/4-inch 316 stainless steel thermo wells shall be provided for all elements

2. Temperature Switches:

a. The Contractor shall furnish and install temperature switches as specified herein.

1) Type: Close coupled direct mount or remote mount where required of ectromechanical type.

2) Contacts: Hermetically sealed SPDT snap action type UL listed 250 VAC, 5A.

3) Housing: NEMA 4X copper free aluminum.

4) Mounting: Minimum of 1/2 inch Stainless steel NPT male thread and 1/4 inch diameter stem. Stem length ("U" dimension) shall be sized to place the stem tip in the center of the vessel or pipeline. Stainless steel 3/4 inch (minimum) NPT male thermo-wells of the proper length shall be provided for all units.

5) Range: Refer to Instrument Range Data.

6) Adjusting Mechanism: Temperature setting values for the range specified shall be indicated on a temperature setting scale. The normal operating range shall be within the middle one-third of the total scale.

7) Dead band: Where possible, temperature adjustments shall include an adjustable dead band.

8) Accuracy: +/- 1% of full scale.

9) Electrical connections: Electrical connections to the switch unit shall be by terminal lugs. In lieu of terminal lugs, a minimum of 19 inch free leads are acceptable for explosion-proof model only. In this case, the leads shall be hermetically sealed, where leaving the switch housing and the seal must be listed by FM and/or UL. When lead type connections are furnished, a separate junction box shall be provided, connected to the switch with flexible conduit and installed. The unit and included box shall comply with all requirements of Division 16 and all area classifications.

10) Over range protection: Temperature switches shall be designed to withstand inadvertent application of temperature equal to 1.5 times full scale rating as a minimum.

11) Manufacturer: SOR, Ashcroft or approved equal.

F. Panel Mounted Instruments

1. Digital Indicators

   a. The Contractor shall furnish and install digital indicators as specified herein.

      1) Function: Display of calculated or real world process variables. Various signals are called out for digital display in the Contract Drawings. Any signals that cannot be displayed on the face of the appropriate SLC (the signal to be displayed must be related to the major function of the SLC), shall be displayed on combination bar graph-numeric readout display units.

      2) Field and Panel Indicators: Unless otherwise noted, alpha-numeric display of indicators mounted in the field shall be LCD type panel mount shall be LED type. The height of alpha-numeric display shall be 1/2-inch minimum. External power supplies shall be provided as needed. Indication shall be in engineering units with a minimum of 1 decimal place display resolution (i.e. XXX.X degree F).

2. Run Time Hour Meters

   a. Type: Provide a synchronous motor driven run-time hour meter with 0.1 hour resolution.

   b. Manufacturer: Cramer, or approved equal.

3. Signal Conditioners

   a. The Contractor shall furnish and install signal converters as specified herein.

      1) Function: Translation of incompatible signal types, ranges, voltages etc. for use by process control equipment.

      2) Type: Converters shall be of the plug in type, utilizing all solid state circuitry suitable for rack mounting within panels.

      3) Power supply: 120VAC, 60 Hz where required by the converter.

      4) Accuracy: 0.1% of span, dead band shall be 0.1% span, maximum.

      5) Where specific converters are not listed, but are required to interface with the current or future process control system, they shall comply with the requirements stated herein.

4. Current Isolators

a. The Contractor shall furnish and install current isolators as specified herein.

1) Function: To provide an isolated current loop, calculations or signal amplification between the plant's new, future and existing process control systems and existing analog instrumentation and control loops.

2) Type: Converters shall be of the plug-in type, utilizing all solid state circuitry suitable for rack mounting within panels.

3) Power supply: 120VAC, 60 Hz where required by the converter.

4) Accuracy: 0.1% of span, dead band shall be 0.1% span, maximum.

5) Circuit loading: Isolators shall be sized such that resistance of new or existing loops shall not exceed maximum rated resistance.

6) Manufacturer: Moore Industries, or approved equal.

5. Current Switch Alarms (alarm trips)

a. The Contractor shall furnish and install current switch alarms as specified herein.

1) Function: To determine fan motor status point in remote starter enclosures.

2) Type: Digital output, solid-core, SPDT relay current sensing switch calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3) Power supply: Self powered induced from line.

4) Alarm Trips: Adjustable setpoint 0.5-200amps

5) Output: SPDT; 1amp rating at 30 VAC/VDC.

6) Manufacturer: Veris-Hawkeye, or approved equal.

G. Piping and Fittings

1. Piping and fittings for connection of instrumentation shall be stainless steel pipe in accordance with the following:

a. General:

1) Piping shall be fabricated in accordance with ASTM A312 from type 316L stainless steel.

2) The pipe shall be subjected to hydrostatic and flattening tests as specified in ASTM A530.

3) All welds shall be free from burrs, snags or rough projections.

4) Where instrument piping is run a distance greater than 24 inches and where directed by the Engineer, 1/2 inch OD, 316 stainless steel tubing shall be used. Fittings shall be 316 stainless steel flareless "Swagelok" or approved equal.

b. Wall Thickness:

1) Shall be schedule 40S for 1/2 inch pipe sizes. The wall thicknesses for the above schedules shall conform to ANSI B36.19.

c. Fittings:

1) Shall be fabricated from type 316L stainless steel in conformance with ASTM A774 of the same wall thickness as specified for the pipe.

2) Shall conform to the requirements of ANSI B16.9 Standard for Factory Made Wrought Steel Butt Welding Fittings. Elbows shall be long radius.

3) Fittings shall be subject to the same hydrostatic test as the pipe.

H. Automatic Temperature Control Devices

1. Thermostats

a. The Contractor shall furnish and install room thermostats in all areas unless otherwise noted, in accordance with the following.

1) Function: Temperature based on / off control of heating and cooling equipment.

2) Type: Industrial, single or two stage, line voltage on / off control.

3) Switch Type: Single or dual, sealed, snap action contacts.

4) Contact Rating: 120Vac, 7.4A.

5) Operating Range: 35 - 100 degrees F.

6) Maximum Ambient: 145 degrees F.

7) Enclosure: NEMA 4X; clear plastic cover; tamper proof setting dial, visible through cover; external mounting tabs.

8) Sensor: external coiled capillary, tinned copper/ corrosion resistant.

9) Adjustments: Internal set point, adjustable interstage differential.

10) Provide separate HAND-OFF-AUTO switch in NEMA 4X enclosure as required.

11) Manufacturer / Model: Honeywell T631F, G, or approved equal.

2. Temperature Elements/Transmitters

a. The Contractor shall furnish and install temperature elements and transmitters as specified herein.

b. Function: Measurement of air and water temperatures of environmental air systems for transmission to HCS/PLC control system.

c. Transmitter: Loop powered, 3-wire RTD to 4-20 mAdc mounted in cast iron probe head. The unit shall have 0.1% full scale accuracy with integral zero and span adjustments. Hart protocol shall not be required.

d. Indicator: Loop powered local LCD indicators shall be furnished and installed when indicated. As a minimum, all room sensors shall have local indicators. Indicators shall be mounted in an easily visible location with the centerline at 5 feet 0-inch above finished floor. The unit shall comply with requirements specified under the section on Digital Indicators above. The enclosure shall be in accordance with Specification 23 09 14.

e. Manufacturer:

1) Omega Engineering Inc. Model: (Probe) type PR-12, (transmitter) TX-92,

2) Or approved equal.

3. Valve Actuators (Two Position and Modulating)

a. The Contractor shall furnish and install valve actuators in accordance with the following.

1) Function: Electrically controlled operation of small valves .

2) Type: Commercial, 120 Vac, 2 position, high torque, spring return to closed position and modulating actuators.

3) Aux Switch Type: 2 sets, adjustable snap action contacts, 120Vac 7.2A.

4) Rating: 120Vac, w/screw terminal adapter.

5) Modulating signal: 4 to 20 mAdc.

6) Operating Range: -40 - +150 degrees F.

7) Mounting: External mounting foot.

8) Enclosure: Cast aluminum, NEMA 4X.

9) Motor/Gear Train: Oil immersed.

10) Mechanical ratings: 160 degree stroke, 60 seconds, 60 lb-in. Torque (min).

11) Accessories: Furnish and install NEMA 4 power disconnect switch for each operator.

12) Manufacturer / Model: Honeywell M4185, 86 or approved equal (2 position) and Honeywell M7284 (modulating) or approved equal.

4. Freeze-stats

a. The Contractor shall furnish and install freeze-stats (low temperature switches) in accordance with the following.

1) Function: To provide a switch contact change of state in response to a low temperature (near freezing) condition at the outlet side of an air handling unit's heating coil.

2) Type: Coil face mounted, extended capillary sensor with manual reset snap action switch.

3) Range: 30 to 60 degrees F.

4) Switch Rating: SPDT 5A, 120Vac.

5) Housing: NEMA 4X, gasketed.

6) Capillary: 1/8 inch x 20 feet (minimum) copper with mounting clips (additional units shall be provided for larger coils or multiple coils as required).

7) Manufacturer: Honeywell, Barber-Coleman or approved equal.

8) The capillary shall be mounted on the downstream side of the heating coil and shall be extended in a zig-zag pattern to cover the entire coil face or in accordance with the manufacturer's written recommendations. The unit shall

respond to the lowest temperature over any one-foot section of the capillary. Multiple units shall be provided for HVAC units having large coils and / or multiple coils to obtain proper coverage and protection. In addition to indicating a freeze condition to the HCS, the units shall be hardwired into the unit control panel and fan control circuit to provide shutdown of the unit. Upon activation, any circulating pumps shall remain operating or shall be started to prevent freezing of the coils. Units shall require manual reset.

5. Differential Pressure Switches

   a. The Contractor shall furnish and install filter differential pressure switches in accordance with the following.

      1) Function: To provide a switch contact change of state in response to increased differential pressure.

      2) Type: Low pressure (<1 inch w.c.) two port differential pressure switch.

      3) Range: 0.2 to 1.0 inch of water column.

      4) Switch Rating: SPDT 15A, 120Vac, form “C” contact.

      5) Housing: NEMA 4X.

      6) Tubing: 1/4 inch ID stainless steel (tubing shall be straight with machine bent corners and securely fastened, provide connection fittings as required).

      7) Manufacturer: Dwyer, or approved equal.

      8) Model: 1638.

6. Filter Differential Pressure Switch/Indicators

   a. The Contractor shall furnish and install filter differential pressure indicators in accordance with the following.

      1) Function: To provide indication and alarm of differential pressure across a filter bank and provide alarm functions on increased differential pressure due to dirt accumulations on filter media.

      2) Type: Low pressure (<1-inch w.c.) two port differential pressure indicator and switch with dual setpoint indicator/adjustment pointers.

      3) Range: 0 to 1.0 inch of water column.

4) Switches: One form "C" contact for each setpoint rated 1A at20 to 280 Vac. Adjustable high and low setpoint indicators.

5) Housing: die cast aluminum, Iridite dipped. Unit shall be semi flush mounted in a NEMA 4X stainless steel enclosure with power supply, tubing and electrical connections and wiring terminals.

6) Connections: 1/8 inch NPTF connection tubing shall be stainless steel (tubing shall be straight with machine bent corners and securely fastened, provide connection fittings as required).

7) Manufacturer: Dwyer, Photohelic, or approved equal.

8) Model: Series A3000MR.

9) Switch/indicators shall be provided for all HVAC units having filters. Where multiple filter types are employed, (paper, carbon, metal, etc.), each filter type shall have an individual indicator. Units shall be panel mounted or mounted in a separate NEMA rated box. Units shall be piped to the filter location and alarm switch.

7. Control Valves (2 inch and smaller)

a. The Contractor shall furnish and install 2-inch and smaller control valves in accordance with Section 40 05 56 – Valves Smaller than 4 Inches and the following:

1) Function: To provide on/off or modulating flow control of hot or cold water in heating / cooling hydronic systems.

2) Type: Linear control and constant total flow globe valves.

3) Material: Body-Cast Bronze, Disk and Seat-brass, Stem-Stainless steel.

4) Temperature range: 40 degrees F to 250 degrees F.

5) Flow Characteristics: Two way or three way (as required), linear, constant total flow through full plug travel.

6) Leakage: Class IV (0.05% of Cv).

7) Manufacturer: Honeywell V5013N, or approved equal.

8) Actuator: See above.

9) Remarks: The valve shall be supplied from the factory with the manufacturer's properly sized electric motor driven actuator. The valve shall be properly sized by the Contractor

for optimum control based on the manufacturer's published data, control system and hydraulic requirements. Isolation and bypass valves and threaded unions shall be installed at all connections to allow easy removal of the valve for servicing while maintaining water supply to the unit.

8. Control Valves (2 1/2 inch to 6 inch)

   a. The Contractor shall furnish and install 2 1/2 through 6 inch control valves in accordance with the Specification 22 05 23.12 – Ball Valves for Plumbing Piping, 22 05 23.14 – Check Valves for Plumbing Piping and the following:

      1) Function: To provide on/off or modulating flow control of hot or cold water in heating / cooling hydronic systems.

      2) Type: Two way or three way (as required), linear control and constant total flow globe valves.

      3) Material: Body-Cast Iron ANSI CLASS 125 flanges, Trim-Bronze, Stem- Stainless steel.

      4) Temperature range: 40 degrees F to 250 degrees F.

      5) Dimensions: Per ISA 75.03 Face to face.

      6) Packing: Teflon cone.

      7) Flow Characteristics: Three way, equal percentage.

      8) Leakage: Class IV (0.01% of Cv).

      9) Manufacturer: Honeywell V5011, V5013B (mixing) and V5013C (diverting) or approved equal.

      10) Actuator: See above.

      11) Remarks: The valve shall be supplied from the factory with the manufacturer's properly sized electric motor driven actuator. The valve shall be properly sized by the Contractor for optimum control based on the manufacturer's published data, control system and hydraulic requirements. Isolation and bypass valves and threaded unions shall be installed at all connections to allow easy removal of the valve for servicing while maintaining water supply to the unit.

9. Control Valves (Larger Than 6 inch)

   a. The Contractor shall furnish and install control valves larger than 6 inch in accordance with the Specification 22 05 23.12 – Ball Valves for Plumbing Piping, 22 05 23.14 – Check Valves for Plumbing Piping and as indicated herein.

1) Function: To provide on/off or modulating flow control of hot or cold water in heating/cooling hydronic systems.

2) Type: Linear control and constant total flow globe type valves with skirt guided V port plug.

3) Material: Body-Cast Iron ANSI CLASS 125 flanges, Trim - 316 Stainless Steel, Stem- Stainless steel.

4) Temperature range: 0 degrees F to 450 degrees F.

5) Dimensions: Per ISA 75.03 Face to face.

6) Packing: Teflon V Ring.

7) Flow Characteristics: Two way or three way, equal percentage, mixing.

8) Leakage: Class IV.

9) Manufacturer: Dezurik Series 1600 model 1601 or approved equal.

10) Actuator: Pneumatic diaphragm direct or reverse acting as required. Failure mode (either air or signal) spring to bypass position, 3-15 psi with 4-20mAdc positioner and 4-20mAdc position feedback, Diaphragm - Buna N with nylon insert.

11) Remarks: The valve shall be supplied from the factory with the manufacturer's properly sized diaphragm driven actuator and positioner. The positioner shall have indicator gauges for supply, input and output air pressure. The valve shall be properly sized by the Contractor for optimum control and minimum head loss based on the manufacturer's published data, control system and hydraulic requirements. Head loss and control characteristics shall be coordinated with the system requirements. Provide gauges and valves on all air lines. Instrument air piping and conditioning equipment shall be provided under this Contract.

I. Ionization Type Smoke Detectors (4 Wire Type for Non-Classified Areas)

1. Furnish and install ionization type duct smoke detectors in the supply and return air ducts or plenum of each H&V unit and in the exhaust air duct of systems where shown on the Drawings.

2. The detector housing shall be listed per UL 268A specifically for use in air handling systems. The detector shall operate at air velocities of 500 to 4000 feet per minute. The detector housing shall be equipped with an integral mounting base capable of accommodating either photo electronic or ionization detector heads. It shall be capable of local testing via remote

testing station. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL 268A, Standard for Smoke Detectors for Duct Applications. The housing shall be capable of mounting to either rectangular or round ducts without brackets. An integral filter system shall be included to reduce dust and residue effects on detector and housing, thereby reducing maintenance and service.

3. Detectors shall be provided with two sets of contacts to provide smoke alarm signals. One is to be used by the HVAC ATC systems, and the second to be used for interface to a central fire alarm system.

4. Remote test station and alarm indicator stations shall be furnished for all duct smoke detectors as specified above. The detector shall be reset by the remote test station. The installation and wiring of the remote stations will be provided under this Section. The remote test stations shall be wall or column-mounted within the visible location of the smoke detector and easily accessible from the floor. The test station shall be key-operated, with "Test', "On", and "Reset", positions.

J. Electric and Electronic Actuators

1. Damper Actuators (Two Position and Modulating)

a. Type: Motor operated, with or without gears, electric and electronic.

b. Manufacturers:

1) Ruskin

2) Johnson Controls

3) Belimo

4) Or approved equal.

c. Voltage:

1) 24 V.

2) Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

3) Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

d. Construction:

1) Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

2) 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.

3) Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

e. Field Adjustment:

1) Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.

2) Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

f. Two-Position Actuators: Single direction, spring return or reversing type.

g. Modulating Actuators:

1) Capable of stopping at all points across full range, and starting in either direction from any point in range.

2) Control Input Signal:

a) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 4 to 20 mA signals.

h. Position Feedback:

1) Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.

2) Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.

3) Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

i. Fail-Safe:

1) Where indicated, provide actuator to fail to an end position.

2) Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.

3) Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

j. Integral Overload Protection:

1) Provide against overload throughout the entire operating range in both directions.

2) Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

k. Damper Attachment:

1) Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.

2) Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.

3) Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

4) Contract drawings are diagrammatic. The actual quantity and location of damper/louver actuators required is to be determined by the Contractor and manufacturer. The actual load on any one actuator shall not exceed 80% of continuous rating. Additional actuators shall be furnished and installed to achieve the needed torque at no additional cost to the City. When additional actuators are provided, the limit switches shall be series connected. The Contractor shall provide the proper mounting hardware, linkages and adapters required for all units. Linkages shall be furnished and installed as recommended by the valve, damper and actuator manufacturer. End limit switches are required and shall be provided on all two position units. The switches shall be connected so that all units must complete full travel (minimum of 85%) before activation of the circuit (contacts close). Switches shall be adjustable over the entire range. All actuators shall be housed in separate NEMA 4X enclosures.

l. Temperature and Humidity:

1) Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of -40 to +150 degrees F.

2) Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

m. Enclosure:

1) Suitable for ambient conditions encountered by application.

2) NEMA 250, Type 2 for indoor and protected applications.

3) NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.

4) Provide actuator enclosure with a heater and controller where required by application.

n. Stroke Time:

1) Select operating speed to be compatible with equipment and system operation.

o. Sound:

1) Spring Return: 62 dBA.

2) Non-Spring Return: 45 dBA.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. All instruments shall have an engraved stainless steel information tag. As a minimum the tag shall indicate the full instrument tag number, manufacturer, model, range and serial number. The tags shall be affixed with stainless steel screws. When screw mounting is not possible, a braided stainless steel lanyard shall be used. Characters shall be 1/8 inch minimum.

B. Each wall or stand mounted electronic instrument shall have mounted adjacent to it an engraved laminated tag, (white with 1/4 inch black letters), indicating tag number, system, subsystem and measured variable. Engravings shall be approved by the Engineer.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. General

1. Instruments shall be installed and oriented so as to be easily accessible and readable from the process floor.
2. Pressure gauges, thermometers, flow indicators, etc. when possible, shall be grouped and oriented so that all indicators of a particular system or subsystem can be viewed by the operator from a single location on the process floor. Whenever possible this central location shall be the unit or system control panel or local control station.
3. Electronic instruments of a single system or subsystem shall have their indicators and transmitters grouped so as to facilitate calibration and viewing by personnel.
4. Unless otherwise specified, instrument enclosures shall be 316 SS or copper free cast aluminum construction. PVC coating shall be provided where severe corrosion is indicated.
5. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by manufacturer.
6. It is the purpose and intent of these Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, and the installation of instrumentation and controls shall be provided under this Contract.
7. Taps and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, orientation and dimensions of the connections and taps for instrumentation furnished under this Section are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation.
8. The Contractor shall coordinate panel and field instrumentation which are in the same control loop. These instruments shall be of the same manufacturer and/or shall be fully matched.
9. Panel mounted instruments such as loop controllers shall be provided with a slide out chassis.
10. Instruments and controls shall contain no mercury in any quantity for any purpose.

B. Location

1. Instrument locations indicated on drawings are diagrammatic. Actual locations shall be as close to the drawing locations as possible, in

accordance with the manufacturer's recommendations, field verified and approved by the Engineer.

2. Location and mounting detail drawings for all equipment shall be submitted to the Engineer for review and approval prior to any work commencing.

3. Transmitters, electronic indicators, etc. and any device requiring routine maintenance shall be wall or stand mounted at between 4-1/2 and 5 feet above finished floor with connections to process as required.

4. Equipment shall be installed in locations approved by the Engineer and out of the way of potential damage. Items shall be installed so as to provide ease of maintenance and operation. Equipment shall not be installed where it impedes access or egress within an area. In addition, the installation shall not block or impede maintenance or operational access to other equipment.

5. Instruments and indicators shall be installed and oriented to allow the operator or service personnel to read the device while at the local control location of the associated equipment. When no local control location is provided, a central location at the equipment shall be chosen by the Engineer. All indicators and readouts shall be located so as to be readable from the process floor.

C. Mounting

1. All instruments and equipment shall be securely and rigidly supported and mounted. Equipment shall be supported by structural members and not from other equipment or systems. When instruments such as gauges and switches are supported by pipe nipples, the pipe size shall be 1/2 inch minimum to the process pipe. Where shown on the drawings, mounting details shall be followed. All equipment specified under this Section shall be installed per the Contract Documents, manufacturer's recommendations and standard industry practice. When installation methods are not shown or specified, the manufacturer's recommendations shall be used after review and approval by the Engineer. All mounting and supporting hardware and appurtenances shall be furnished and installed under this Contract.

2. Where process taps or an instrument are located more than 10 feet above finished floor, or where subject to severe or damaging vibration, instruments, both electronic and non-electronic, shall be wall or stand mounted at eye level and tubing or capillary run to the process tap. With the approval of the Engineer, pressure gauges and thermometers mounted between 10 and 20 feet above the floor shall be provided in an 8 inch size rather than having remote tubing connections.

3. When pressure gauges are mounted at 6 feet or more above the finished floor, elbows shall be used as needed to articulate gauges and indicators at a 45 degree angle to provide easy viewing from the floor.

4. Instruments requiring calibration shall not be mounted more than 8 feet above the floor or their access platform. Such instruments shall be remote mounted and tubed or connected with armored capillary as appropriate, and mounted at eye level.

5. Pressure transmitters, differential pressure indicators (gauges) and transmitters shall be wall or stand mounted and tubing run to the process taps.

6. Field instruments mounted outdoors shall be mounted in thermal insulated enclosures fitted with thermostatically controlled space heaters to suit the environment. The front door of enclosure shall have a glass window to allow easy viewing of the indicator.

D. Process Connections

1. Instrument connections shall be oriented to provide optimal sensing conditions and eliminate transmission and entrapment of air, condensate, grit, particles, moisture, etc.

2. Instruments mounted in plastic, ductile iron or lined pipe shall be flanged (2 inch minimum) and provided with isolation valves. Instrument connections to vessels shall be flanged and provided with isolation means.

3. Temperature sensing elements for insertion into process piping and vessels shall be provided with a 3/4 inch NPT (minimum) stainless steel thermowell. Thermo-wells shall be provided for each temperature measurement system (thermometer, temperature switch, RTD, etc.) and shall comply with SAMA RC17 10. The probe and thermo-well insertion depth ("U" dimension) shall be selected to place the tip of the probe as near the center of the pipe or vessel as possible. Industry standard insertion depths shall be used when at all possible. Extended lagging type units shall be provided on all insulated vessels or pipes.

4. Armored capillary lines shall be furnished and installed on all remote mounted temperature indicators. The capillary shall be securely attached to walls or columns and secured with straps and screws at a spacing not to exceed 3 feet and within 18 inches of the devices. Bends, if required shall have the proper radius and shall be squared off. The tubing shall be run parallel or perpendicular to piping and other surfaces.

5. All process taps for pressure instruments shall have an isolation valve located as close to the point of process connection as possible and at the instrument. Valves shall be bolted three piece ball type with 316 stainless steel body and parts. Valves shall be 1/2 inch for clean service and 1 inch for dirty service.

6. When remote connected by tubing to the process tap, the connecting tubing shall be ASTM A269 316L seamless stainless steel with "Swagelok" type flareless fittings, 1/2 inch OD minimum for clean service and 3/4 inch OD for dirty service (effluent water etc.). Tubing and capillaries shall be secured over their entire length. Tubing shall be field bent using proper tools with fittings only being used where necessary. Rippled, kinked or flattened bends will be rejected and shall be discarded. Tubing shall be run neatly, squarely and parallel with or perpendicular to piping and structures. One half inch stainless steel ball valves shall be provided at both ends of the tubing. Valved flushing/calibration connections shall also be provided. Tubing shall be pitched to eliminate air or condensate from the lines. A "dirt leg" with a clean out valve and plug shall be installed directly below the point where the instrument is connected to the tubing

7. Pipeline and vessel mounted instruments shall have a stainless steel three piece coupling /union mount to allow removal from the process for calibration and testing without opening the process or disconnecting the electrical conduit or wire.

8. Differential pressure devices shall be provided with an factory mounted integral three valve calibration manifold in addition to the other required valving. When a factory mounted unit is not made, a field fabricated unit shall be constructed. Prior written approval of the unit shall be required.

9. Where vibration may be present, instruments shall be wall or stand mounted and tubing or capillary run to the process. If mercury type switches are to be used they must be securely mounted and isolated from movement and vibration.

E. Electrical Requirements

1. Instruments requiring electrical power or signal connections shall have sufficient length of flexible conduit and wire to allow easy removal without disconnection from the system. Flexible connections shall be a minimum of 12 inches and a maximum of 24 inches long unless otherwise approved by the Engineer in writing.

2. Electrical connections of wires to instruments shall be by screw terminal. When an instrument or device's terminals will not accept a #12 awg control or power wire, or when factory installed pigtails are provided, a suitable junction box, in accordance with Division 16 and area classification, shall be furnished and installed with and connected to the instrument.

3. All instruments requiring 120 Vac power shall be supplied with an external power disconnect switch and surge suppressor. The switch and suppressor shall be rated NEMA 4X and fabricated of stainless steel. Under this Contract the instrument shall be connected to the switch and isolator using

3/4 inch liquid tight flexible metal conduit and #12 awg conductors. In hazardous areas all work shall comply with the NEC and electrical specifications. Coordinate all installations with electrical installer.

F. Heat Tracing and/or Insulation

1. Heat tracing and insulation shall be provided when there is possibility of process fluid freezing or setting up. Refer to Contract Drawings for heat tracing details.

2. Instrument tubing in unheated areas or buildings shall be protected against freezing or setting up by insulation and heat tracing.

3. Any instrument, process pipe and tubing containing a non-flowing fluid which will precipitate at ambient temperature or has freezing point above ambient temperature shall be heat traced and insulated.

4. Any instruments close coupled to insulated and/or heated process pipe or equipment shall also be insulated and/or traced.

5. Pressure gauges used in services where freezing or setting up is a problem shall be equipped with diaphragm seals. Pressure switches, pressure, and differential pressure transmitters shall also be so connected in similar situations.

6. In case of filled type temperature instruments, the filling fluid shall be selected such that no heat tracing or insulation is required for the capillaries.

3.03 FIELD TESTING / QUALITY CONTROL

A. General

1. The Contractor shall, through the services of the HCS Supplier, comply with the requirements of Specification 23 09 15 – Instrumentation and Controls System Testing, Installation and Startup for all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein.

2. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

3. The HCS Supplier shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer

performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the City. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

4. At least 60 days before the anticipated initiation of installation testing, the Contractor shall electronically submit to the Engineer of the detailed description of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

5.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Field Instrument Calibration Requirements

1. The HCS Supplier shall provide the services of factory trained instrument technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by NIST (National Institute of Standards and Technology).

3. The HCS Supplier shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposal calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to over voltages, incorrect voltages, over pressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the City.

6. After completion of instrumentation installation, the HCS Supplier shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all Contractor representatives involved for each loop test and witnessing Engineer.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install, test and place in satisfactory operating condition, control panels, equipment enclosures and associated devices as indicated in the Specifications, and as shown on the Contract Drawings. The term enclosures shall apply to both equipment enclosures and control panel enclosures. All control panels and equipment enclosures shall be designed, assembled, and furnished by the Heating and Ventilating Control Systems Supplier (HCS Supplier). The equipment shall be installed by the Contractor in accordance with the Specifications, manufacturer's recommendations, Contract Drawings, and best industry practice, together with all wiring, terminations, etc. to interface all instrumentation and controls, as required. Panels and enclosures shall be installed under the direct supervision of the HCS Supplier. Mounting equipment such as brackets, stands, hardware and appurtenances shall be provided as required.

B. This section includes:

1. Requirements for all control panels and equipment enclosures housing control and instrumentation equipment, PLC, wiring, terminals, etc.
2. Control Panel Fabrication.
3. Equipment Enclosures.
4. Control Panel Equipment and Devices.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 09 00 - Instrumentation and Controls Scope and General Requirements for HVAC.

B. Section 23 09 13 - Instruments and Control Devices for HVAC.

C. Section 23 09 14 – Control Panel, Enclosures and Devices for HVAC.

D. Section 23 09 15- Instrumentation and Controls System Testing Installation and Startup for HVAC.

E. Section 23 05 93 - Testing, Balancing and Adjusting.

1.04 REFERENCES

A. All equipment and services provided herein shall be in accordance with the references stated in the Specification 23 09 00 – Instrumentation and Controls Scope

1.05 DESCRIPTION

A. Not used.

1.06 QUALITY ASSURANCE

A. Not used.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited to:

1. Action Submittals:

a. Equipment Specifications and data sheets identifying all materials used and methods of fabrication.

b. Complete assembly, layout, installation and foundation drawings with clearly marked dimensions

c. Detailed fabrication drawings of all equipment provided under this Section. Drawings shall show materials; all dimensions both internal and external; internal equipment layout, dimensions and spacing; power input and wiring terminal locations; mounting location, heights, finishes and installation details.

d. Detailed data sheets, installation manuals, instruction and operation manuals, manufacturers literature, options and all other pertinent information for all equipment provided under this Section.

e. Complete schematic wiring diagrams and internal point to point wiring diagrams for all units.

f. Factory and field testing procedures and certified results.

2. Informational Submittals:

a. Spare Parts List.

b. Special Tools List.

c. Reports of Certified Shop Tests.

d. List of Lubricants.

1) The manufacturer shall submit a list with a minimum of four (4) manufacturer’s standard lubricants which may be used interchangeably for each type of lubricant required.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The cleaning, preservation, and packing of the control panels, enclosures, and devices for shipment shall be in accordance with the manufacturer's commercial practice.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The control panels, enclosures, and devices shall be handled in such a manner that they may be transported and unloaded without being over-stressed, deformed, or otherwise damaged.

2. The control panels, enclosures, and devices shall be protected from corrosion and deterioration and shall be stored in a dry area.

a. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with effective and durable waterproof covers approved by the Engineer.

C. Interiors shall be kept free from dirt and foreign matter.

D. Each panel shall be identified with purchaser's complete order number and tag number on a metal tag securely wired to the panel. Each component requiring identification for proper assembly shall be tagged separately.

E. Panel shall be so packaged and packed that, with customary handling; it will be protected from damage in shipment. Each shipping section shall be mounted on skids.

F. Before packing, all equipment shall be clean and dry.

G. All electrical wiring leads between panel sections shall be clearly marked for reassembly and shall be coiled and rigidly held within the panel framework.

H. Special handling instructions shall be conspicuously placed on all equipment requiring unusual handling and shipping care.

I. In general, standard panel instruments such as indicators, which can be damaged during transit shall be removed and shipped separately.

J. When equipment is transported to the Site by ship, the following shall apply:

1. All equipment shall be shipped as below deck cargo.

2. Whenever practicable, panels shall be bolted to container frames. All exposed tubing, wiring, and instruments shall be protected by padding. Containers shall be lined with water proofing materials.

3. Instruments shipped separately shall be packed in moisture-proof containers with a desiccant and held in a fixed position with packing.

4. Crates and boxes shall be reinforced with steel straps. Crates and boxes with a net weight in excess of 400 lbs. shall have diagonal bracing on all faces. When net weight is in excess of 500 lbs., skids shall be bolted to the container frames.

K. All equipment, once assembled, whether stored at the factory, on Site or at a remote location, shall be kept protected and free from damaging environmental conditions. Unless otherwise specified, equipment shall be kept in a dry, dust free, temperature-controlled area, free from temperature and humidity fluctuations, and in accordance with the equipment manufacturer’s recommendations. As a minimum, temperature shall be kept above 55 degrees F and no condensation shall occur.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Provide all of the individual manufacturers recommended spare parts and tools for all equipment specified herein. In addition to the recommended spares, furnish all of the following minimum spare parts, tools and devices.

1. General

a. 20% (minimum of 10) spare fuses, lamps for indicating lights, etc., for each size and type provided.

2. Relays, Circuit Breakers, Fuse Holders, etc.

a. 10% (minimum of 2) spares of each size, type and configuration for each 10 or part thereof installed.

3. Panel Mounted Switches, Push Buttons and Indicating Lights

a. 10% (minimum of 2) spares of each size, type, color and configuration for each 10 or part thereof installed including contact sets).

4. Terminals and Mounting Strips

a. 20% (minimum of 10) spares of each size, type and configuration for each 10 or part thereof installed (including mounting rail).

5. Specialty Items Not Listed

a. 10% (minimum of 2) spares of each size, type and configuration for each 10 or part thereof installed.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not used.

2.02 MATERIALS / EQUIPMENT

A. General:

1. The Contractor shall furnish and install control panels and enclosures to house all instrument, control and electronic equipment, wiring, terminals and accessories. Control panels and enclosures shall be assembled, wired, and tested in the HCS Supplier's own or other Engineer/City approved facility of his choosing. All components and all necessary accessories such as power supplies, power conditioning equipment, mounting hardware, input and output terminal blocks, plug strips, relays, lighting, circuit breakers, fuses, etc., which may be required to complete the system shall be

provided. Internal layout and internal point to point wiring for typical panels shall be identical.

2. Unless otherwise indicated, panels, enclosures and all exposed panel mounted devices, shall have a minimum of a NEMA 4X rating. Enclosures shall be formed or welded construction reinforced with Unistrut, Powerstrut, or approved equal to stiffen panels and doors and facilitate mounting of internal components or equipment. Enclosures shall be 16 USS gauge for units with all dimensions 24 inches or less, 14 USS gauge for units with all dimension greater than 24 inches and less than 48 inches. Enclosures with any dimension of 48 inches or more shall be 12 USS gauge. All floor mounted units shall be 12 USS gauge and shall be provided with jackscrews for leveling. For large and floor standing panels, each shipping section shall be provided with four removable lifting lugs.

3. Doors shall be formed, with welded continuous hinged swing type with the hinge running vertically. Door swing shall be a minimum of 165 degrees. Door closure hardware on NEMA 12 units shall be a three point closure system with single external lockable handle. Multiple clamp type closure is acceptable for small enclosures containing only terminals or non maintenance items. NEMA 4 and 4X units shall have multiple clamp type closures on three sides of the door with padlock accessories and locks. Sufficient doors and access panels shall be provided to facilitate maintenance and testing of the supplier's equipment. All doors shall be fitted with common keyed locks. The door edges and panel opening shall be rolled to prevent the entrance of water and debris when panels are opened.

4. The use of prefabricated, standard "Hoffman" type industrial enclosures is acceptable. The enclosures shall be purchased factory finished as required herein.

5. Provide additional stiffeners or separate mounting panels for OIT units mounted in panels.

6. Steel members shall be provided in the back of the panel for rigidity and support of wiring, accessories, etc. Stiffeners shall be welded to the back face of the panel where required. Stiffeners shall not interfere with instrument installations and weld marks/discoloring shall not be visible. Sufficient stiffeners and/or supports shall be provided so that the panel face does not distort due to the weight of the instruments or equipment.

7. All equipment and devices shall be identified with engraved nameplates both inside and out. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted and gasketed, with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating.

8. The Contract Drawings show approximate dimensions of control panels and preferred front layout. The Contractor shall be responsible for detailed design of all control panels and enclosures. All panels and enclosures shall have a minimum of 6 inches of clear perimeter gutter space from internal equipment (including terminal strips and wireway) to the enclosure wall. Enclosures with a dimension greater than 36 inches shall have a minimum of 12 inches clear gutter space. Panel enclosures shall not be crowded. Ample space shall be provided between components to allow for heat dissipation and servicing. The internal components shall be arranged such that they can be serviced without removing other components.

9. All control panels shall have a single power supply entry point and a power disconnect switch. Control devices shall be mounted in functional groups in accordance with good panel design practice so as to present a neat and functional appearance and so as to be readily identifiable and accessible for adjustment and service. The panel arrangement shall be approved by the Engineer.

10. All panels and enclosures shall have sub plates and sub panels for mounting equipment. These shall be USS gauge #10 minimum and painted gloss white. A bonding jumper to the enclosure, of #10 AWG copper wire or braid shall be provided.

11. Cut outs shall be made, without distorting the face of the panel, to the dimensions and tolerances specified on the instrument manufacturer's certified drawings. Cutouts shall be saw cut or punched smooth and straight, or round as required, parallel to the panel sides and ground smooth and free from burrs. Flame cutting will not be accepted. Both the front and back surfaces of the panel face near the cut outs shall be level to permit proper instrument installation.

12. Panels shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING This Device Is Connected to Multiple Sources of Power". Letters shall be 1/2 inch high, white.

13. Floor mounted panels shall be free standing, requiring no external bracing or support. Angle Iron framing shall be provided at the bottom part of each panel. The framing shall be box construction, with all corners fully welded, and shall be reinforced with additional members as required to prevent buckling or distortion of the frame or the panel face due to normal handling during transportation and final assembly. The bottom 12 inches of floor mounted panels shall have no equipment or terminals located there.

14. The rack framework shall be welded steel construction 1 5/8 x 5/8 inch using Powerstrut, Unistrut, or approved equal and/or angle iron to provide a rigid assembly. Racks shall be of open, box like framework with all frame supports welded and ground smooth. Steel straps shall be used for locating

terminal blocks. The terminal blocks shall be factory assembled on a miniature mounting channel and the channel bolted to the steel strap.

15. The joints at the bottom of the panel shall be even and flat to within 1/16 inch. Care shall be taken that the weight of each section is carried by the framework, and not by the bottom edge of the panel face.

16. Panels, which are mounted on concrete slab, shall be furnished with base bolt holes at the channel base for use in anchoring the panel to the slab. Removable lifting lugs shall be provided at the top of each panel. All mounting hardware and anchors shall be of 316 stainless steel.

17. Floor standing panels shall have solid bottoms. Panels in control rooms shall have all wireways brought directly into the panel bottom.

18. All panels and enclosures shall be provided with a steel pocket for keeping drawings. One extra set of the as built drawings shall be provided and kept in the panel.

B. Enclosures Materials, Temperature Control, and Area Classification:

1. Enclosures for outdoor service shall be 304 SS NEMA 4X weatherproof construction with clear polycarbonate framed window in hinged and gasketed door to permit full view of all enclosed instrumentation and/or controls without opening. All doors shall be fitted with common keyed locks. Panels shall be suitable for wall or pipe mounting. Panels shall be insulated and equipped with thermostatically controlled internal space heaters for severe winter service. Heaters shall maintain 50 degree F interior temperature at a 0 degree F ambient temperature. Fiber glass enclosures will not be accepted.

2. Enclosures located inside electrical equipment rooms, administrative areas or air conditioned control rooms in non contaminated areas as well as floor standing panels containing an OIT, shall have a minimum of a NEMA 12 rating and shall be corrosion resistant. Corrosion resistant enclosures shall be made of 316 SS, or steel, coated with a powdered resin which is heat-cured 100% solid thermosetting epoxy.

3. Enclosures used in all other areas, except hazardous locations, shall be rated NEMA 4X and shall be fabricated out of 316L stainless steel unless otherwise indicated. All the devices and hardware on the front of NEMA 4X rated panels will be specifically NEMA 4X rated. Splash-proof equipment and hardware shall not be acceptable for mounting on NEMA 4X panels. All enclosures shall include sealed gasketed doors to protect internal equipment from outside air.

4. All enclosures containing heat generating equipment shall include integrally mounted fans to circulate the air within the enclosure and remove heat from the modules. Enclosures and doors shall be designed to dissipate heat

through their exterior surfaces into the plant environment. Air shall not be exchanged between the enclosure's interior and the outside environment. Alternatively, cooling air can be drawn from non-contaminated area.

5. Enclosures and panels located in areas where chlorine liquids or gasses are handled stored or transported, shall be fabricated out of a material suitable for use in such an atmosphere. Material selection shall be approved by the Engineer.

6. Panels and enclosures located in areas required to be or indicated as hazardous shall be constructed to NEMA 7 standards, shall be UL approved for that application and shall be rated for the atmosphere in which they shall be installed. The units shall be rated Class I Division 1 Group D as a minimum. All such panels shall be finished with powder coated thermosetting epoxy resin for corrosion resistance or PVC coated when required. All external devices shall be rated for the application and shall be corrosion resistant.

C. Control, Selector and Push Button Switches

1. Switches and push-button type operators shall be rated for the enclosure in which they are mounted. As a minimum, all devices shall be NEMA 12 and 13, oil and water tight. Switches and operators mounted in NEMA 4X panels shall have a NEMA 4X rating. All operators used on the Project shall be from one manufacturer and shall be the same line.

2. Devices shall be of the 30.5 mm type rated for extra heavy duty service.

3. Selector switches shall have gloved hand operating handles.

4. Push buttons shall be of the guarded type except those being used for stop control.

5. Emergency stop push buttons shall be Push - Pull type with maintained contacts.

6. Control and selector switches for control of 5 KV equipment and circuit breakers shall be switchgear duty control switches General Electric SB1, SBM or approved equal. Circuit Breaker trip control switches shall have 2 parallel contacts. Close switches shall have 2 series contacts. Normal after close and normal after trip contacts shall be provided.

7. Control switches, selector switches, push buttons, etc. for use in explosion proof (NEMA 7) panels and/or equipment located in hazardous areas shall be rated explosion proof for use in Class 1 Division 1 atmospheres.

D. Indicating Lights

1. Indicating lights shall be 120 volt transformer type, with replaceable high intensity L.E.D. type lamp, unless otherwise noted.

2. Indicating lights shall be rated for the enclosure in which they are mounted. As a minimum, all devices shall be NEMA 12 and 13, oil and water tight. Indicating lights mounted in NEMA 4X panels shall have a NEMA 4X rating. All indicating lights used on the Project shall be from the same manufacturer as the operators specified above and shall be the same line.

3. Devices shall be of the 30.5 mm type rated for extra heavy duty service.

4. Indicating lights shall be push to test type. The push to test feature shall not interact with any other circuitry.

5. Indicating lights for use in explosion proof (NEMA 7) panels and/or equipment located in hazardous areas shall be rated explosion proof for use in Class 1 Division 1 atmospheres and shall be push to test type.

E. Relays

1. General purpose control relays shall be the socket mounted type for DIN rail mounting. Relays shall be tube socket or quick connect square base type. Miniature relays are not acceptable. Each relay shall have a minimum of two or three single pole double throw contacts each rated 5 or 10 amps as required. The relays shall have a push to test feature and a coil indicating light. Potter & Brumfield KRP, KUP, or approved equal

2. Relays used for control of motors shall have a horsepower rating above that of the connected motor at the appropriate voltage. Motor overload protection shall be provided.

3. Relays used for emergency shutdown and safety circuits, those common to several pieces of equipment and all relays associated with control or monitoring of 5 KV equipment shall be 4 pole (min.) 600 volt machine tool type. Contacts shall be convertible type with a 10 amp minimum ratings. These units shall be Allen-Bradley class 700 P, or approved equal.

4. Relays used for control of 5 KV or higher circuit breakers shall be utility grade switchgear control relays having the proper AC and DC ratings. These units shall be General Electric type HGA, HFA, or approved equal.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not used.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not used.

2.05 ELECTRICAL REQUIREMENTS

A. All control panels and enclosures shall be powered by 120 VAC unless otherwise specified. UPS protection shall be provided as indicated and will be supplied under this Contract.

B. The wiring terminals shall be rail mount, screw type lift plate or suitable for solderless horseshoe connectors and rated at least 20 amps at 600 volts. The screws for solderless terminals shall be # 8 minimum. They shall be marked with a permanent, continuous marking strip from end to end with the numbers appearing on the approved shop drawings. One side of each terminal strip shall be reserved exclusively for field wiring. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer/City, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable. Terminals for field wires shall be provided in an easily accessible area of the panel.

C. Terminal blocks for current transformer circuits shall be the shorting type. Shorting terminal blocks shall be provided for all C.T. circuits when entering or leaving the panel.

D. Wiring shall comply with accepted standard instrumentation and electrical practices. For each pair of parallel terminal blocks, the field wiring shall be between the blocks. Lift plate or box type terminals shall be used for connecting wires to terminal blocks. Solderless horseshoe connectors with insulating sleeves and # 8 bolt hole shall also be acceptable. The terminals for field wiring shall be properly sized UL approved to accept field wires of #12 gauge. Fused terminal blocks of the same style shall be used for all output connections to field devices.

E. All wiring shall be enclosed in vented plastic wireway with covers. Wireways shall not be filled to more than 40% of capacity. Where wireway is not possible, conductors shall be run open and shall be bundled and bound at regular intervals, not exceeding 6 inches with nylon cable ties. The bundles shall be secured at intervals not to exceed 12 inches. Care shall be taken to separate electronic signal, discrete signal, and power wiring. Where wiring crosses on to a hinged panel, the wiring shall be bundled and run vertically along the hinge as long as possible to better distribute the twisting forces. The bundle shall be secured at both ends to the panels.

F. Interior panel wiring and field wiring shall be color coded and tagged at all terminations and devices with machine printed plastic sleeves. The wire number shall be as indicated on the approved shop drawings.

G. All incoming and outgoing wiring shall terminate on panel terminal blocks unless approved otherwise in writing by the Engineer. The System Supplier shall furnish all wiring between panel mounted instruments and the terminal blocks. Terminal blocks shall be rated at least 600 volts, 20A, Square D Type G, or approved equal.

H. At shipping joints, interpanel wiring shall be completely installed, terminated with terminals, identified, factory tested and then coiled back for shipping.

I. All wiring to devices mounted on enclosure doors shall be extra flexible and enough slack must be provided to prevent any tension when doors are at maximum opening. Wiring bundles run from panels to doors shall be run lengthwise along the hinge to

spread the opening torque along the greatest length of cable. Permanent cable anchors shall be provided at both ends of the cable to eliminate any torque being applied to wiring terminals.

J. All wire mounts shall be either Epoxy glued or screwed to the equipment mounting plate. Screws shall not penetrate the enclosure. Stick on or self sticking wire mounts will not be acceptable.

K. For incoming wiring provide enclosed wiring troughs in the panel reserved for incoming field wires and wireways from the troughs direct to instrument terminals. Provide these troughs at bottom of panel if incoming wiring is from below.

L. Terminal block layout shall be such as to provide ample access to wiring during installation, checkout, and maintenance. Minimum spacing between adjacent terminal blocks and/or panel edge shall be 6 inches. A minimum of 6 inches space shall be provided at the top and bottom of panels and enclosures.

M. Duplicate terminals shall be provided on the panel for common field wires (such as annunciator common, AC power leads, neutrals, etc.) to limit the maximum number of wires on a terminal to two. Spare terminals equal to not less than 25% of the required points shall be furnished. Jumpers if required shall be connected to the panel manufacturer's side of the terminal blocks.

N. All incompatible circuits (such as low level signals) shall be separated from power circuits and/or each other with separate slotted wireway and junction boxes.

O. Wire for 120 Volt, 60 Hz control circuits shall be minimum No. 14 AWG stranded copper, NEC type MTW/THHN with 600 Volt insulation, and minimum 90 degree C rating. AC power wiring shall be 12AWG minimum. Internal wiring for panels controlling 4160 volt equipment, main pumps, blowers, switchgear. etc. shall be wired using 14 AWG tinned copper SIS wire. Wiring for current transformer circuits shall be 10 AWG tinned copper SIS and shall be yellow. Wiring for potential transformer circuits shall be 12 AWG SIS.

P. Wire for 24 volt DC Signals shall be minimum No. 16 AWG stranded tinned copper, shielded twisted pairs. Where terminated or connected, the end of the jacket and shield shall be sealed with heat shrink tubing.

Q. All AC and DC control and power wiring as well as all signal wiring, shall be tagged on both ends. Where Contract Documents have not specified wire numbers, the wire numbering scheme from the approved shop drawings shall be used. Terminals on panel terminal blocks shall be identified with a terminal block number and terminals shall be in sequential order.

R. Instrument transmission and control wires and associated panel terminal shall be identified with the instrument tag number, function, and polarity.

S. Indicating lights color shall be as follows:

Color	Function

Red	Running, Breaker Closed
Amber (flashing)	Alarm
Green	Ready, Breaker Open, Valve Closed
White	Control Power On
Blue	Valve Open

T. Where indicated or required by codes, all panels and panel mounted equipment shall be explosion proof.

2.06 POWER DISTRIBUTION

A. Electrical power shall be distributed throughout the panel and field instrumentation requiring 120 VAC, 60 Hz, by means of a power distribution panel or individual fuses. There shall be a common power disconnect switch.

B. The number of circuit breakers or fuses shall depend upon the process functional requirements. The circuit breakers shall be arranged in neat functional groups so that an overload or short circuit inside the panel shall disable only a part of the process. As a minimum, circuits pertaining to one piece of equipment shall be fused or protected separately to allow servicing of that piece of equipment without affecting others.

C. Surge protectors and power conditioners shall be provided for all electronic equipment located inside the panel. To provide protected power at a level that is safe for all connected equipment.

D. An additional 120 vac duplex receptacle shall be provided in any panel or enclosure which contains equipment that requires programming or calibration. This shall be for powering laptop computers and test equipment only.

2.07 LIGTHING

A. Panels with any dimension 48 inch or greater or a depth in excess of 12 inch shall have internal lighting. Fluorescent lighting shall be used unless it will have a detrimental effect on enclosed equipment. A SPST toggle switch or door actuated switch and lighting fixtures with lamps shall be provided as required to illuminate the entire panel interior.

2.08 GROUNDING

A. Each panel mounted device shall be bonded or otherwise grounded to the subpanel on which it is mounted by means of machine threaded screws with locknuts, lock washers or other pressure mounting methods.

B. Each panel shall be provided with at least two copper ground busses, one for AC instrument power (normally 115 VAC 60 Hz) grounds and one for DC signal grounds. The DC ground bus must be electrically isolated from the panel board.

C. The DC ground bus shall be connected to a remote grounding rod by means of an independently run #2 AWG insulated copper ground wire.

D. Ground busses shall be minimum 1/4 inch x 1 inch x 8 inch with two (#2/0) AWG lugs for connection to plant grounding system. These grounding busses shall be predrilled for connection of instrument, panelboard, or cable shield connection.

E. When panel or field wiring for electronic instruments is specified shielded, a shield terminal shall be provided for each control loop at the terminal strip connection to and from field instruments. Shields shall be connected through the field terminal strip and continued to the equipment connection. Each shield shall be grounded at one point only, and this ground connected to the DC ground bus in the panels or as required by the equipment manufacturer.

F. Subpanels for mounting of internal equipment, enclosure doors and all internal metal objects shall be grounded by means of a #10 AWG bonding jumper.

2.09 CONTROL LOGIC

A. Control logic shall be performed using relays and/or PLCs as indicated and required. When not so indicated, logic shall be performed using hardwired relay logic.

B. Emergency and safety controls, etc. shall be implemented using hard wired relay logic. Relays for these functions shall be 600 volt machine tool type. These systems shall include but not be limited to:

1. HVAC Fire Alarm Interlock

C. The control logic for fan/damper control, stop/start operation of rooftop units, heating and ventilating units, dehumidification units, Supply and Exhaust fans shall be implemented using relay logic with PLC monitoring where indicated.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not used.

3.02 INSTALLATION

A. All panels and enclosures shall be mounted straight, level and parallel to building surfaces.

B. Wall mounted panels and enclosures shall be securely mounted to walls or columns as indicated. They shall be spaced a minimum of 3/4 inch from the structure using strut or plates.

C. Stand mounted units shall be supported using steel channel securely mounted to the floor with a minimum of four 1/2 inch stainless steel bolts. Stands shall be secure and level, shall easily support the mounted equipment and shall hold the equipment rigidly.

D. All free standing control panels shall be installed on a 6 inch wide and 4 inch high reinforced concrete curb with chamfered corners. The curb shall be 1 inch larger than the panel on all sides.

E. When panels or enclosures are installed on raised grating floors, additional supports and bracing shall be provided under the floor as required to prevent the floor from being overloaded. Large and/or heavy panels having any dimension larger than 72 inches or weighing 300 lbs or more or where the weight of the completed panel exceeds 80% of the specified load bearing capacity of the flooring, shall be supported from the structural sub floor independently of the raised floor. Provide a welded steel support framework the size of the unit footprint capable of rigidly supporting the weight of the entire panel with a 50% safety factor. The floor system shall be installed flush and level with this frame. Load and bracing calculations shall be submitted for review.

F. The Contractor shall comply with manufacturer stated floor installation requirements. In areas where floor modifications are required, and the floor has already been installed, the Contractor shall retain the services of an approved flooring subcontractor to make the appropriate modifications at no additional cost to the City.

3.03 FIELD TESTING / QUALITY CONTROL

A. All control panels and enclosures provided under this Contract shall be factory and field tested in accordance with Sections 23 09 15 – Instrumentation and Controls System Testing, Installation and Start-up for HVAC.

3.04 STARTUP / DEMONSTRATION

A. Not used.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not used.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall test all equipment provided under this Contract, in accordance with Specification 01 75 10 - Preliminary and Final Field Tests, all requirements of individual Specification Sections and as required herein. The Contractor shall retain the services of the Heating, Ventilating and Air Conditioning Control Systems Supplier (HCS Supplier) to furnish labor, supervision, materials, equipment and incidentals as required to properly install, thoroughly test and startup the HCS as required herein

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Specification Section 23 09 00 - Instrumentation and Controls, Scope and General Requirements for HVAC.

B. Specification Section 23 09 13 – Instrumentation and Control Devices for HVAC.

C. Specification Section 23 09 14 – Control Panels, Enclosures, and Devices for HVAC.

D. Specification Section 23 09 93 – Sequence of Operation for HVAC.

1.04 REFERENCES

A. All equipment and services provided herein shall be in accordance with the references stated in the Specification 23 09 00 - Instrumentation and Controls - Scope and General Requirements for HVAC.

1.05 DESCRIPTION

A. The Contractor shall retain the services of the HCS Supplier to perform the following functions:

1. Select all equipment, perform a detailed design, provide all Shop Drawings and coordinate integration of the entire HVAC control systems.

2. Perform a comprehensive integrated system factory test of all components, hardware and software at his manufacturing facility prior to shipment of any equipment to the Site.

3. Direct and supervise the installation, mounting, connecting, piping and wiring of all field, panel and control room instrumentation, controls and computer equipment and test same per the Contract Documents, manufacturers' recommendations and best industry practice.

4. Perform field testing and calibration of all equipment provided, in accordance with the Contract Documents and as recommended by the manufacturers and specified reference standards.

5. Participate in and perform startup activities on all equipment provided as part of the Contract, participate and assist in startup and testing of all equipment monitored and controlled by his system.

1.06 QUALITY ASSURANCE

A. All testing, installation and startup duties shall be performed by certified, well trained experienced personnel as required by Specification 23 09 00 -

Instrumentation and Controls Scope and General Requirements for HVAC and shall be directly supervised by the Project Engineer.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for all equipment and Work provided, for the approval of the Engineer in accordance with Specification 01 33 00 – Submittal Procedures.

B. Complete system installation and layout drawings of all equipment shall be submitted to the Engineer for approval. Layout drawings shall reference the same areas as the Contract Drawings but shall indicate actual proposed locations, heights and orientation of all equipment.

C. Installation and mounting details based on actual equipment shall be submitted for approval on all items. These shall include weights, dimensions, orientation, and method of mounting and special considerations or requirements.

D. Prior to commencing any testing, the Contractor shall submit complete and detailed test procedures for all testing required. All testing submittals are to be reviewed by the Engineer for approval. Proposed log sheets and report formats containing all information to be recorded and results of all tests shall be included in the submittal. Test procedures shall be submitted early enough to be approved at least 30 Days prior to testing.

E. Prior to acceptance of any equipment for operation by the City, all reports of satisfactorily completed tests shall be approved. Any waiver of this requirement must be in writing from the Engineer.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not used.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not used.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not used.

2.02 MATERIALS / EQUIPMENT

A. Not used.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not used.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Factory Testing

1. When Shop Drawing review of all pertinent items is completed and equipment has been procured, fabricated, programmed and assembled and prior to shipment of any equipment to the Site, a fully integrated Factory System Test shall be performed at the HCS Supplier's facility. When the factory tests have been successfully completed, a certified copy of all test results shall be furnished to the City together with a clear and unequivocal statement that all factory test requirements have been met.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Simulators and test equipment may be used for Preliminary Field Testing but actual field and process conditions shall be used for Final Testing unless waived in writing by the Engineer.

3.02 INSTALLATION

A. Upon successful completion of all factory testing and remediation of any outstanding items, the Contractor shall begin field installation of the components of the HCS systems. Installation shall proceed in a timely and orderly fashion with all components being installed per the approved Shop Drawings and the Contract Documents. During installation, the Contractor shall perform its own tests on all completed equipment and systems to verify proper operation prior to field acceptance testing required by the Contract Documents.

B. The Contractor shall install all equipment in accordance with the Contract Documents, Working Drawings, manufacturers' recommendations, and best industry practice.

C. Equipment shall be installed level and plumb, parallel, or perpendicular to building structures, spaced from walls and at an elevation that will ease startup and system maintenance. When no installed height is given for instruments or controls, a centerline height of 60 inches shall be assumed. For control panels, the top of the panel enclosure shall not exceed a height of 78 inches nor shall any control devices or indicators be located above 72 inches or below 42 inches.

D. Equipment shall be mounted and secured so as to provide sound and rigid support, ease of maintenance and accurate and dependable operation.

E. All equipment associated with the HCS shall be installed by highly qualified personnel using the utmost care to provide a neat, highly functional, efficient and professional installation.

F. Electrical equipment, conduit system, wire, etc. shall be installed and tested in accordance with Division 26 of the specifications and the Contract Drawings.

3.03 FIELD TESTING / QUALITY CONTROL

A. Once a sufficient portion of the HCS has been installed and is operational as determined by the Engineer, the Contractor shall begin field testing of individual components and subsystems as they are completed. The Engineer reserves the right to witness all testing.

B. Preliminary field testing of an individual component may begin when the unit is properly installed and fully connected to the process.

C. Preliminary and Final Field testing of systems and subsystems shall only proceed when, in the opinion of the Engineer, the entire system under test has been completed and is operational. The Final Field Testing of control systems shall only be done when all controlled and driven equipment is operational and under system control. To be used in Final Field Testing of the HCS or subsystems, the term operational shall mean that the controlled and driven equipment and all associated items, (starter. etc.) have passed their own Preliminary and Final Field Tests.

D. Preliminary and Final Field tests required of the HCS and associated subsystems shall include but not be limited to:

1. Preliminary Field testing of systems including.
    a. Field Calibration of all instruments and controllers.
    b. Control panel field tests.
    c. Preliminary operational tests of control strategies and all system logic.
    d. Individual testing of equipment control systems with operational equipment. (Pumps, HVAC, etc.)
2. Final Field testing of systems including:
    a. Integrated system field test.
    b. System optimization and final tuning.

E. To achieve satisfactory completion of any test, approval of the Engineer in writing shall be required. Satisfactory completion of a test shall only be achieved when all components of the system under test are functioning properly and concurrently for a sustained period as required by Specification 01 75 10 - Preliminary and Final Field Tests.

F. Preliminary Field Testing

1. The Contractor shall perform Preliminary Field Testing for all equipment and systems provided as part of the HCS. All tests performed as part of the Factory Test shall also be performed as part of the Field Testing. The following is a minimum listing of procedures required to be completed for Preliminary Field Testing of the referenced equipment.

    a. Calibration

        1) All field instruments shall be factory calibrated and certified for the ranges required. Field verification shall be performed for all instruments prior to operation.

    b. Control Panel Testing

        1) Upon completion of all interconnecting wiring and control circuitry between the control panel, equipment, instrumentation, and related systems each control panel and equipment enclosure shall be subjected to a control panel installation test. Each panel shall be fully inspected and tested for function, operation, and continuity of all circuits between the control panel and all connected devices. Control strategies, equipment operation, logic, safety, interlock, and indication functions shall be verified. A log book shall be maintained by the Contractor for this purpose.

        2) Upon the satisfactory completion of all control panel installation tests, a certified report, including all test documentation, shall be furnished to the Engineer together with a clear and unequivocal statement that the installed panels have been successfully inspected and tested.

    c. Testing of Individual Equipment

        1) The Contractor is advised that the HCS and subsystems thereof will be required to be used as an integral part of field testing of other equipment. The Contractor is further advised that personnel of the HCS Supplier shall be required to participate in such testing to make their systems available in a manner suitable for testing of the devices under test. HCS signals shall be field calibrated and certified prior to use in testing of other equipment.

        2) Each piece of HVAC equipment, fan, etc. shall be fully tested with its subsystem of the HCS in order to satisfactorily complete its Final Field Test of Equipment. Such equipment shall be required to respond to HCS signals in order to comply with their Equipment Final Field Testing requirements. Satisfactory operation of all associated equipment and controls in accordance with the requirements

of Specification 01 75 10 – Preliminary and Final Field Tests shall complete testing for both parts of the system under test.

G. Final Field Testing

1. General

a. The Contractor shall perform Final Field Testing for all equipment and systems provided as part of the HCS. Final Field Testing of the HCS shall require that all Preliminary and Final Field Testing of all individual HVAC equipment items be completed, and the equipment be operational prior to commencing any tests. HVAC equipment, including air handlers, fans, etc. shall be operated by the system for all Final Field Testing.

2. Integrated System Field Test

a. The Contractor shall perform an Integrated System Field Test on the HCS as a complete system including all HVAC equipment (air handlers, fans, etc.).

b. Each piece of equipment shall be started and stopped both manually and automatically from Local Control Panels. Set points and sequences shall be changed, lead / lag systems tested and response documented. All normal process functions shall be tested.

3.04 STARTUP / DEMONSTRATION

A. General

1. Upon satisfactory completion of all testing, systems shall be started and brought on line to support and supply facility needs. The Engineer shall be notified 1 week prior to starting or bringing any system online for the first time and 2 Days prior on subsequent starts.

2. The Contractor shall retain the services of the HCS Supplier to provide highly qualified personnel to work along with DEP operators to finely tune all control loops; modify control algorithms, strategies and sequences; revise calculations and provide technical advice as required to bring the entire HCS systems to optimum performance and efficiency. Optimization and tuning hot water distribution and space heating systems will require that a real plant load be available. Seasonal timing may require that optimization and fine tuning of these systems may have to be done after acceptance of the equipment during the next heating season.

3. Equipment, strategies, and systems shall be fine-tuned to achieve:

a. Stable system operation at set point.

b. Timely delivery of required energy or product to loads.

c. System operation free from oscillation and error.

d. Minimized energy consumption.

e. Minimized cycling of equipment.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not used.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

The Contractor shall employ the services of the HCS supplier to provide all programming, controls and required items and services to furnish a system that enables the heating and ventilating systems and equipment to function properly and in accordance with the sequences and schedules specified herein and as indicated by the Contract Documents.

Process control functions shall be structured to permit the realization of all control strategy requirements. Where applicable, operator adjustable parameters shall be automatically defaulted to a preset value if a specific value is not given during system generation.

The following index of this Section is presented for convenience:

1.02 PAYMENT

No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

Specification Section 23 09 00 – Instrumentation and Controls Scope and General Requirements for HVAC.

Specification Section 23 09 13 – IC Devices for HVAC

1.04 REFERENCES

All equipment and services provided herein shall be in accordance with the references stated in the Specification 23 09 00 - Instrumentation and Controls - Scope and General Requirements for HVAC.

1.05 DESCRIPTION

This Section includes the intended sequences of operation / control strategies for the HVAC systems and the overall HVAC Control philosophy and requirements. In addition:

1. The basic HVAC control philosophy shall be as follows:
    a. As a minimum, the system shall permit the operator to run each system and piece of equipment in the following modes:
        1) Automatic: Control strategies shall be implemented generally by the designated control processors with minimal operator intervention.
        2) Local Manual: Plant shall be run by the operator by means of local field devices with full monitoring and alarming by the system.
2. Single point or single system failure shall not disable the plant or equipment operation.
3. All personnel safety and equipment protection interlocks and alarms shall be hardwired and active in all modes of operation.

Control Strategies – Definitions

4. The control strategies are written descriptions of the basic configuration and/or programming required to implement regulatory and sequential control of the unit processes as shown on the Control Diagrams and as stated herein. They do not in all cases describe the process characteristics fully, many of which may become apparent only during start up and testing. Any function blocks necessary to compensate for the process characteristics shall be provided and implemented as necessary until the Final Acceptance of the plant. Control strategies shall monitor the position of all switches

and the status and availability of all equipment under its control. Failure of a system or piece of equipment to operate as expected shall generate an alarm to the system.

Hardware

5. Control Diagrams show only the minimum necessary hardware. The HCS Supplier shall provide all the hardware, whether or not shown or specified, that may be necessary to implement the control strategies as described.

Configuration

6. All set points, tuning parameters and engineering units, ranges, etc., shall be documented for each control point and each control strategy on configuration sheets or similar documents. These documents shall be updated during factory testing and finally during start-up.

7. All set points, operating limits, time delays, alarm points, alarm conditions, etc. shall be fully adjustable, within an appropriate range from the local control panels whether specified or not.

8. Control strategy implementation shall comply with all related Sections of Division 23.

Control of HVAC Equipment

9. A fire condition initiation of shutdown via the existing central fire alarm system (CFAS) panel shall be implemented as specified herein and where indicated on the Contract Drawings. The fire alarm panel shall initiate a contact opening to each local HVAC equipment's controller (motor starter, VFD, etc) to signal a fire condition and stop the fan(s) and close all the appropriate dampers and louvers. The interface between the individual HVAC equipment's controllers and the fire alarm panel shall be through addressable relays and monitoring modules.

10. The control system shall notify the operator by alarm if a unit is not ready, not in either automatic mode or running. The operator shall have the option to disable this feature on a unit by unit basis.

11. Appropriate and adjustable time delays shall be provided during a system recovery from shutdown, power failure, etc., to prevent all ventilation units from restarting at the same time.

12. All equipment shall recover from power failure by coming back ready to operate.

1.06 QUALITY ASSURANCE

Not used.

1.07 SUBMITTALS

Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:
    a. Detailed, written sequence of operation for each system, describing how the system will operate, the various modes of operation, alarms and individual equipment control functionality as well as all interlocked devices.

1.08 DELIVERY, STORAGE, AND HANDLING

Not used.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

Not used.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Not used.

2.02 MATERIALS / EQUIPMENT

Not used.

2.03 FABRICATION / ASSEMBLING / FINISHES

Not used.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

Not used.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

Not used

3.02 APPLICATION

General HVAC System Control Strategies (Applies to All Fans)

1. All controls required to implement the control sequence strategy shall be furnished under this section of the Specifications.
2. The control system shall be housed in a NEMA 4X control panel, unless otherwise indicated. Each control panel shall be provided with:

a. Start/stop push button.

b. Hand-off-auto switches.

c. Indication lights – for ready, run status.

d. Alarm light for smoke (or fire), freeze and dirty filter.

3. Control logic for heating, ventilating, fans, etc. shall be implemented locally using DDC or PLC logic within the individual local control panel (LCP). Temperature control shall be implemented using individual local temperature controllers. Refer to Contract Drawings or equipment schedule and control diagrams for complete listing of interlocking schemes.

4. A freezestat shall be located downstream of each heating coil for HV units. Operation of the freezestat shall be as previously specified.

5. A normally closed dry contact shall be provided to each HVAC fan's (including those inside the Dehumidifcation units) starter / VFD controller to initiate shut down of the HVAC equipment in a smoke/fire condition from the central fire alarm system (CFAS). Duct mounted smoke detectors shall be furnished and wired by the Electrical Contractor where indicated on the Contract Drawings. Upon detection of smoke from the duct detector, an alarm to the CFAS shall be activated, and the respective HVAC fans shall shut down after receipt of signal from the CFAS. Shutdown shall occur in any mode of operation of the HVAC systems, i.e. manual, automatic, etc. All fan systems must be manually reset at the CFAS after a smoke condition before restarting.

6. Motor operated smoke dampers shall be provided where indicated on the Contract Drawings. Operation of the smoke dampers shall be as previously specified.

7. Normally closed dry contacts shall be provided to the system panel for shut down of equipment in an emergency condition. Upon activation of a Emergency Stop (E-Stop) switch, an alarm to the LCP shall be activated, and the HVAC control panel shall initiate the shut-down of the necessary HVAC equipment.

8. Differential pressure switches shall be installed in the filter banks of the units to sense pressure drop through the filters on the supply and return air side for HV, HRU, fans, etc. Operation of the differential pressure switch shall be as previously specified.

9. All control devices shall be suitable for corrosive atmosphere.

10. Interconnecting wiring and conduits between the field mounted devices such as discharge controllers, motor operated dampers, and between local and remote panels, etc. shall be furnished and installed under Specification

23 09 00 – Instrumentation and Controls Scope and General Requirements for HVAC and this section of the Specifications.

TITLE: SCREEN CHAMBER VENTILATION CONTROL

DRAWING(S): KSCR-H-302, KSCR-H-401, KSCR-H-805

EQUIPMENT: EF1-1, EF1-2 (standby), EF2-1, EF2-2, EF2-3, EF2-4 (standby)
MOD-PV-1, PV-2, MOD SV-1, SV-2, SV-3, SV-4

CONTROL PANEL: SC-HLCP-01

DESCRIPTION:

11. Primary Ventilation Automatic Operation (via Manual-Auto Selector Switch)
    a. With the MANUAL/AUTO selector in the AUTO position, EF1-1, EF1-2, EF2-1, EF2-2, EF2-3, and EF2-4 shall be interlocked.
    b. When the panel mounted selector switches for EF1-1, EF1-2, EF2-1, EF2-2, EF2-3, and EF2-4 are in the AUTO position, EF1-1 exhaust air motorized damper and primary ventilation intake air motorized dampers MOD-PV-1 and MOD-PV-2 shall be indexed to open.
    c. When EF1-1, MOD-PV-1, and MOD-PV-2 motorized dampers have fully opened, as proven by their damper motor end switches, EF1-1 exhaust fan shall start and run continuously.
    d. Logic within the HVAC Local Control Panel SC-HLCP-01 shall be provided to operate the exhaust fans EF1-1 and EF1-2, including a Lead/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.
    e. CO Gas Detection: When a high level alarm input signal is received from the carbon monoxide gas detection system controller during Manual or Automatic mode, exhaust fans EF1-1 or EF1-2 shall be immediately stopped and their exhaust air dampers automatically closed. The logic within the HVAC Local Control Panel SC-HLCP-01 shall provide ventilation switchover Secondary Ventilation mode.
12. Secondary Ventilation Automatic Operation (via Manual-Auto Selector Switch)
    a. With the MANUAL/AUTO selector in the AUTO position, EF1-1, EF1-2, EF2-1, EF2-2, EF2-3, and EF2-4 shall be interlocked.
    b. When the HVAC Local Control Panel SC-HLCP-01 receives a high level alarm signal from the carbon monoxide gas detection system

controller, EF2-1, EF2-2, and EF2-3 motorized exhaust air dampers and intake air motorized dampers MOD-SV-1, SV-2, SCV-3 and SV-4 shall be to open.

c. When EF2-1, EF2-2, and EF2-3 motorized exhaust air dampers have fully opened, as proven by their motor end switches, EF2-1, EF2-2, and EF2-3 shall start and run continuously until the high level carbon monoxide signal is cleared at the carbon monoxide gas detection system controller. Logic within the HVAC local control panel SC-HLCP-01 shall be provided to operate the exhaust fans EF2-1, EF2-2, EF2-3 and EF2-4, including a Lead/Standby configuration for EF2-4. In the event one of the three fans is inoperable during a CO detection event, the standby fan shall be started.

d. Once the high-level carbon monoxide signal is cleared at the carbon monoxide gas detection system controller, the HVAC local Control Panel SC-HLCP-01 shall resume Primary Ventilation mode as described above.

13. EF1-1 and EF1-2 Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector switch of the exhaust fan is in the MANUAL position, the exhaust fan shall be started by pushing the START button.

b. Upon pressing the START push button, the exhaust fan's exhaust air motorized damper and motorized intake air dampers MOD-PV-1 and MPD-PV-2 shall be indexed to open.

c. When the exhaust fan's motorized exhaust air damper and intake air MOD-PV-1, and MOD-PV-2 motorized dampers have fully opened, as proven by their damper motor end switches, the exhaust fan shall start.

d. Selecting the STOP push button will cause the exhaust fan to stop immediately and close the exhaust and intake air dampers.

e. If during MANUAL operation the HVAC Local Control Panel SC-HLCP-01 receives a high level alarm signal from the carbon monoxide gas detection system controller, the HLCP shall resort to Secondary Ventilation Automatic Operation mode.

14. EF2-1, EF2-2, EF2-3, and EF2-4 Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector switch of the exhaust fan is in the MANUAL position, the exhaust fan shall be started by pushing the START button.

b. Upon pressing the START push button, the exhaust fan's exhaust air motorized damper and motorized intake air dampers MOD-SV-1, SV-2, SV-3 and SV-4 shall be indexed to open.

c. When the exhaust fan's motorized exhaust air damper and intake air MOD-SV-1, SV-2, SV-3 and SV-4 motorized dampers have fully opened, as proven by their damper motor end switches, the exhaust fan shall start.

d. Selecting the STOP push button will cause the exhaust fan to stop immediately and close the exhaust and intake air dampers.

e. If during MANUAL operation the HVAC Local Control Panel SC-HLCP-01 receives a high level alarm signal from the carbon monoxide gas detection system controller, the HLCP shall resort to Secondary Ventilation Automatic Operation mode.

15. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

a. A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

b. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

c. An airflow switch shall be provided in the exhaust ductwork near the inlet of each exhaust fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

16. SCADA System Alarms: The following common alarms shall be sent to the plant's SCADA system. Each common listed alarm below shall be provided through a set of dry contacts in the local control panel for SCADA system interface.

a. TBD

17. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

18. Duct mounted smoke duct detectors shall be located Upstream of the exhaust fans as indicated on the Contract Drawings and shall be furnished and wired under this Contract. Operation of duct mounted smoke detectors and remote CFAS shutdown signals shall be as previously specified.

TITLE: INJECTOR ROOM VENTILATION CONTROL

DRAWING: KSCR-H-304, KSCR-H-402, KSCR-H-803

EQUIPMENT: EF-3, DHU-2

CONTROL PANEL: WA-HLCP-03

19. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector in the AUTO position, EF-3 and DHU-1 shall be interlocked.

    b. With the MANUAL/AUTO selector in the AUTO position, DHU-2 shall run under its own local control sequence. Refer to Specification Section 23 84 19 – Desiccant Dehumidification Units. The Dehumidification unit shall provide a run signal to the HVAC Local Control Panel WA-HLCP-03 for EF-3 start interlock.

    c. When the panel mounted selector switch for EF-3 is in the AUTO position, and the HVAC local control panel WA-HLCP-03 receives a run signal from DHU-2, EF-3 exhaust air motorized damper shall be indexed to open.

    d. When EF-3 motorized damper has fully opened, as proven by its damper motor end switch, EF-3 exhaust fan shall start and run continuously.

    e. When the HVAC local control panel WA-HLCP-03 receives an off signal from DHU-2, EF-3 shall shut down and its exhaust dampers shall close.

    f. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel, the local control panel shall immediately shut down DHU-2 and EF-3 and close EF-3 exhaust air dampers.

20. DHU-2 Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for DHU-2 in the MANUAL position, the dehumidification unit shall be started by pushing the START button.

    b. Upon pushing the START button, the dehumidification unit DHU-2 shall operate under its own local control. Refer to Specification Section 23 84 19 – Desiccant Dehumidification Units.

    c. With the MANUAL/AUTO selector for DHU-2 in the MANUAL position. Upon pushing the STOP push button, the dehumidification unit DHU-2 shall immediately stop.

    d. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel and the MANUAL/AUTO selector for DHU-2 is in the MANUAL position and the unit is running, the dehumidification unit shall immediately stop.

21. EF-3 Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for EF-3 in the MANUAL position and upon pressing the START push button, the exhaust fan shall start and run independent of the dehumidification unit DHU-2. Upon pushing the START button, the exhaust damper shall open. When the exhaust damper has fully opened, as proven by the damper motor's end switch, the exhaust fan will start. Pushing the OFF pushbutton will cause the fan to stop immediately and close the exhaust dampers.

    b. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel and the MANUAL/AUTO selector for the exhaust fan is in the MANUAL position and the fan is running, the fan shall immediately stop and its exhaust dampers shall close.

22. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

    a. A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

    b. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

    c. An airflow switch shall be provided in the exhaust ductwork near the inlet of each exhaust fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

23. SCADA System Alarms: The following common alarms shall be sent to the plant's SCADA system. Each common listed alarm below shall be provided through a set of dry contacts in the local control panel for SCADA system interface.

    a. TBD

24. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: RAW WATER STRAINER, WATER QUALITY MONITORING, AND FLUORIDE ROOM VENTILATION CONTROL

DRAWING: KSCR-H-304, KSCR-H-402, KSCR-H-403, KSCR-H-804

EQUIPMENT: DHU-1, EF-4

CONTROL PANEL: WA-HLCP-04

DESCRIPTION

25. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector in the AUTO position, EF-4 and DHU-1 shall be interlocked.

    b. With the MANUAL/AUTO selector in the AUTO position, DHU-1 shall run under its own local control sequence. Refer to Specification Section 23 84 19 – Desiccant Dehumidification Units. The Dehumidification unit shall provide a run signal to the HVAC Local Control Panel WA-HLCP-03 for EF-4 start interlock.

    c. When the panel mounted selector switch for EF-4 is in the AUTO position, and the HVAC local control panel WA-HLCP-03 receives a run signal from DHU-1, EF-4 exhaust air motorized damper shall be indexed to open.

    d. When EF-4 motorized damper has fully opened, as proven by its damper motor end switch, EF-4 exhaust fan shall start and run continuously.

    e. When the HVAC local control panel WA-HLCP-03 receives an off signal from DHU-1, EF-4 shall shut down and its exhaust dampers shall close.

    f. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel, the local control panel shall immediately shut down DHU-1 and EF-4 and close EF-4 exhaust air dampers.

26. DHU-2 Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for DHU-1 in the MANUAL position, the dehumidification unit shall be started by pushing the START button.

    b. Upon pushing the START button, the dehumidification unit DHU-2 shall operate under its own local control. Refer to Specification Section 23 84 19 – Desiccant Dehumidification Units.

    c. With the MANUAL/AUTO selector for DHU-1 in the MANUAL position. Upon pushing the STOP push button, the dehumidification unit DHU-1 shall immediately stop.

    d. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel and the MANUAL/AUTO selector for DHU-1 is in the MANUAL position and the unit is running, the dehumidification unit shall immediately stop.

27. EF-3 Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector for EF-4 in the MANUAL position and upon pressing the START push button, the exhaust fan shall start and run independent of the dehumidification unit DHU-2. Upon pushing the START button, the exhaust damper shall open. When the exhaust damper has fully opened, as proven by the damper motor's end switch, the exhaust fan will start. Pushing the OFF pushbutton will cause the fan to stop immediately and close the exhaust dampers.

b. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel and the MANUAL/AUTO selector for the exhaust fan is in the MANUAL position and the fan is running, the fan shall immediately stop and its exhaust dampers shall close.

28. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

a. A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

b. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

c. An airflow switch shall be provided in the exhaust ductwork near the inlet of each exhaust fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

29. SCADA System Alarms: The following common alarms shall be sent to the plant's SCADA system. Each common listed alarm below shall be provided through a set of dry contacts in the local control panel for SCADA system interface.

1) TBD

30. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: ELECTRIC ROOM THERMOSTATICALLY CONTROLLED FANS

DRAWING: KSCR-H-303, KSCR-H-402, KSCR-H-403, KSCR-H-801

EQUIPMENT: EF-6, EF-7 (standby), GIH-1

CONTROL PANEL: WA-HLCP-01

DESCRIPTION:

31. Hand Operation: With the remote mounted Hand-Off-Auto switch of the respective fan in the "Hand" position the system shall open all associated

dampers. When the dampers have fully opened, as proven by the damper motor end switch, the fan shall start.

32. Off: When the Hand-Off Auto switch is placed in the "Off" position, the fan shall stop immediately and all dampers shall close.

33. Auto Operation: With the Hand-Off-Auto switch in the "Auto" position, the respective fans shall be started and stopped by the room thermostat. Set point of the fans' thermostat shall be 95 degrees F (unless indicated otherwise on the Contract Drawings). Set points shall be field adjustable. Operation of the fans' start and stop sequence shall be the same as for hand operation.

34. Logic within the HVAC Local Control Panel WA-HLCP-01 shall be provided to operate the exhaust fans EF-6 and EF-7, including a Lead/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

35. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

36. Remote Controls: The Contractor shall furnish, install and connect a remote room thermostat as indicated.

37. Smoke Shutdown: Fans shall shut down in any mode upon signal from the CFAS as previously specified.

TITLE: ELECTRIC UNIT HEATERS CONTROL

DRAWING(S): KSCR-H-402

EQUIPMENT: EUH-1

DESCRIPTION:

38. Each electric unit heater shall be provided with a two stage room thermostat with a "Hand-Off-Automatic" switch. With the switch in the "Automatic" position, the room thermostat shall stop or start the fan to maintain room conditions at the set point. In the "Hand" position, the fan shall operate continuously.

39. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

40. All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

TITLE: POLICE BOOTH VENTILATION SYSTEM CONTROL

DRAWING(S): KSPB-H-401, KSPB-H-902, KSPB-H-903

EQUIPMENT: EAF-1, EDH-1, ERV-1, MD-1, MD-2, FSD-1, FSD-2

CONTROL PANEL: PB-HLCP-01

DESCRIPTION:

41. Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for ERV-1 in MANUAL position upon pressing the START push button, the motorized dampers MD-1 and MD-2 shall open. When the damper has fully opened, as proven by the damper motor's end switch, ERV-1 fans shall start. Pushing the OFF pushbutton will cause ERV-1 fans to stop immediately and close the motorized dampers.

    b. Upon visual confirmation of exterior doors in the Police Booth being open post which with the MANUAL/AUTO selector for EAF-1 in MANUAL position upon pressing the START push button, the motorized dampers MD-1 and MD-2 shall open, combination fire and smoke dampers FSD-1 and FSD-2 shall open. When the motorized damper and combination fire and smoke damper has fully opened, as proven by the damper motor's end switch, EAF-1 fan shall start. Pushing the OFF pushbutton will cause EAF-1 fans to stop immediately and close the motorized dampers.

42. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector in the AUTO position. Logic within the HVAC Local Control Panel PB-HLCP-01 shall be provided to operate the fans in automatic operation based on a field adjustable building occupancy schedule.

    b. When PB-HLCP-01 receives a run signal from ERV-1, MD-1 and MD-2 motorized dampers shall be indexed to open. FSD-1 and FSD-2 combination fire-smoke dampers shall be indexed to closed.

    c. When MD-1 and MD-2 have fully opened and FSD-1 and FSD-2 have fully closed, as proven by the damper motor end switches, ERV-1 shall run under its control sequence.

    d. With the MANUAL/AUTO selector for EDH-1 electric duct heater in the AUTO position, and when ERV-1 supply fan is running, as proved by its air flow switch, the duct thermostat shall modulate the electric duct heater controller to meet supply air setpoint. Set point of the duct heater's thermostat shall be 68 degrees F (unless indicated otherwise on the Contract Drawings). Set points shall be field adjustable.

e. When the HVAC local control panel PB-HLCP-01 receives an off signal from ERV-1, MD-1 and MD-2 shall close. FSD-1 and FSD-2 shall remain closed. EDH-1 shall de-energize.

43. Clean Agent HVAC System Shutdown:

a. Fans EAF-1, ERV-1, duct heater EDH-1 and Variable Refrigerant Flow (VRF) shall shut down in any mode upon signal from the clean agent system control panel.

b. All combination fire smoke dampers and motorized dampers shall close in any mode upon signal from the clean agent system control panel.

44. Post-Event Clean Agent Purge:

a. Upon visual confirmation of exterior doors in the Police Booth being open purge mode shall be activated by purge switch at clean agent system control panel to allow the rooms to be purged entirely of clean agent after a discharge has occurred.

b. When purge mode activated by purge switch, FSD-1 and FSD-2 combination fire smoke dampers and MD-1 and MD-2 motorized dampers shall be opened by signal from clean agent system control panel. Upon confirmation from end switches that dampers are open, EAF-1 exhaust fan shall energize in purge mode until purge switch is manually deactivated.

45. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

a. Logic within the HVAC Local Control Panel PB-HLCP-01 shall be provided to prevent EAF-1 and ERV-1 running simultaneously.

b. Clean agent system control panel shall have shutdown control of the HVAC equipment in all modes.

c. An airflow switch shall be provided in the ductwork near the discharge of each fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the Local Control Panel when airflow is not detected.

46. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: POLICE BOOTH HEATING AND AIR CONDITIONING SYSTEM CONTROL

DRAWING(S): KSPB-H-401, KSPB-H-902, KSPB-H-903

EQUIPMENT: ACU-1, ACU-2, ACU-3, ACU-4, ACCU-1, EUH-1, BBH-1 (x3), BBH-2 (x3), BBH-3 (x2), BBH-4 (x1)

CONTROL PANEL: PB-HLCP-01

DESCRIPTION:

47. Air Conditioning Units

    a. The indoor air conditioning units ACU-1, ACU-2, ACU-3 and ACU-4 shall be controlled via room thermostat and controller furnished by the unit manufacturer.

48. Electric Unit Heaters

    a. Each electric unit heater shall be provided with an internal adjustable thermostat. The internal thermostat shall stop or start the fan to maintain room set point. The internal thermostat shall deenergize the electric heating coil when the fan is off and energize the electric heating coil when the fan is on.

    b. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

    c. All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

49. Electric Baseboard Heaters

    a. Each electric baseboard heater shall be provided with a built-in adjustable thermostat. The built-in thermostat shall activate or deactivate electric heating element to maintain room conditions at the set point.

    b. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition.

    c. All controls, instruments, panels, and all electrical equipment associated with baseboard heaters shall be approved for the service and classification where installed.

50. Normal Operation:

a. Air conditioning unit controller shall vary refrigerant flow as needed to maintain space temperature cooling setpoint. The ACU fans to operate continuously.

1) Security Room cooling setpoint shall be 75 degrees F (adjustable).

2) Control Room cooling setpoint shall be 75 degrees F (adjustable).

3) Electrical Room cooling setpoint shall be 85 degrees F (adjustable).

b. Electric unit heater shall activate or deactivate heating element and fans as needed to maintain space temperature heating setpoint.

1) Electrical Room heating setpoint shall be 60 degrees F (adjustable).

c. Electric baseboard heaters shall activate or deactivate heating element as needed to maintain space temperature heating setpoint.

1) Security Room heating setpoint shall be 68 degrees F (adjustable).

2) Control Room heating setpoint shall be 68 degrees F (adjustable).

51. Clean Agent System Shutdown:

a. Indoor units ACU-1, ACU-2, ACU-3 and ACU-4 shall shut down in any mode upon signal from the clean agent system control panel.

b. Outdoor unit ACCU-1 shall shut down in any mode upon signal from the clean agent system control panel.

52. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

a. Leak detection for ceiling cassette indoor air conditioning units shall be provided by the Contractor. If water sensor detects presence of water, a visual alarm shall be generated at the local control panel PB-HLCP-01 and the ceiling cassette indoor unit shall shutdown.

b. If space temperature rises 2 degrees F (adjustable) above cooling setpoint for a 10-minute (adjustable) time period, the indoor air conditioning unit's controller shall generate a visual alarm at the local control panel PB-HLCP-01.

c. In Electrical Room, if space temperature drops 2 degrees F (adjustable) below heating setpoint for a 10-minute (adjustable) time period, a space temperature sensor shall generate a visual alarm at the local control panel PB-HLCP-01.

d. The local control panel PB-HLCP-01 shall monitor dry contact provided by the indoor air conditioning unit manufacturer. A visual alarm shall be generated at PB-HLCP-01 upon system alarm/trouble.

e. The local control panel PB-HLCP-01 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at PB-HLCP-01 in the event of an over temperature condition.

f. The local control panel PB-HLCP-01 shall monitor a dry contact from each electric baseboard heater, provided by manufacturer. A visual alarm shall be generated at PB-HLCP-01 in the event of an over temperature condition.

g. Clean agent system control panel shall have shutdown control of the equipment in all modes.

TITLE: ELECTRICAL BUILDING UNIT SUBSTATION ROOM AND MV SWITCHGEAR ROOM HVAC SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-904, KSEB-H-905, KSEB-H-906

EQUIPMENT: RTU-1, RTU-2, EAF-1, EAF-2 (standby), EAF-3, EAF-4 (standby), SAF-1, SAF-2 (standby), SAF-3, SAF-4 (standby), MD-01, MD-02, MD-03, MD-04A, MD-04B, MD-05, MD-06A, MD-06B, MD-07, MD-08A, MD-08B, MD-09, MD-10A, MD-10B, FSD-01, EUH-3 (x6)

CONTROL PANELS: EB-HLCP-01, EB-HLCP-02

DESCRIPTION:

53. Unit Substation Room HVAC System Control

a. The Unit Substation Room is served by supply and exhaust fans, in duty/standby configuration, to provide mechanical ventilation to maintain space setpoint. When it is not possible to meet space setpoints through mechanical ventilation, a rooftop air conditioning unit provides the necessary heating or cooling.

b. The supply fans and rooftop air conditioning unit share the same supply air distribution ductwork and require motorized dampers to isolate the inactive equipment. Likewise, the exhaust fans and rooftop air conditioning unit share the same return air distribution ductwork and require motorized dampers to isolate the inactive equipment.

c. The Unit Substation Room HVAC system setpoints are as follows:

1) Cooling setpoint = 95 degrees F (adjustable)

2) Heating setpoint = 60 degrees F (adjustable)

d. Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the fans and rooftop air conditioning unit as follows:

1) If outside air dry bulb temperature is greater than 80 degrees F or space temperature is less than 60 degrees F:

a) EAF-1, EAF-2, SAF-1 and SAF-2 are disabled

b) RTU-1 operates in automatic mode

2) If outside air dry bulb temperature is less than or equal to 80 degrees F and space temperature is greater than or equal to 60 degrees F:

a) EAF-1, EAF-2, SAF-1 and SAF-2 operate in automatic mode

b) RTU-1 is disabled

e. EAF-1, EAF-2, SAF-1 and SAF-2 Automatic Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector in the AUTO position, supply fans SAF-1 and SAF-2 shall be interlocked to exhaust fans EAF-1 and EAF-2.

2) When the panel mounted selector switches for EAF-1, EAF-2, SAF-1 and SAF-2 are in the AUTO position, motorized dampers MD-04A, MD-04B, MD-10A and MD-10B shall be indexed to closed. The fans shall be started and stopped by the room thermostat.

3) When the LCP receives a signal to start fans, MD-04A and MD-10A shall be indexed to open, MD-03 and MD-09 shall be indexed to closed.

4) When motorized dampers MD-04A and MD-10A have fully opened and MD-03 and MD-09 have fully closed as proven by their damper motor end switches, SAF-1 supply fan and EAF-1 exhaust fan shall start and run continuously.

5) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the supply fans SAF-1 and SAF-2, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

6) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the exhaust fans EAF-1 and

EAF-2, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

f. EAF-1, EAF-2, SAF-1 and SAF-2 Manual Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector switch of the fan in the MANUAL position, the fan shall be started by pushing the START button.

2) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to only allow one supply fan to operate at a time to prevent damage to the supply ductwork system.

3) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to only allow one exhaust fan to operate at a time to prevent damage to the exhaust ductwork system.

4) Upon pressing the START push button, the motorized damper corresponding to the fan shall be indexed to open, MD-03 and MD-09 shall be indexed to closed.

5) When the motorized damper corresponding to the fan is fully opened and MD-03 and MD-09 have fully closed as proven by their damper motor end switches, fan shall start.

6) Selecting the STOP push button will cause the fan to stop immediately and close the motorized damper corresponding to the fan.

g. RTU-1 Automatic Operation (via Manual-Auto Selector Switch):

1) When the panel mounted selector switch for RTU-1 is in the AUTO position, and the HVAC local control panel EB-HLCP-02 receives a run signal from RTU-1, MD-03 and MD-09 motorized dampers shall be indexed to open, MD-04A, MD-04B, MD-10A and MD-10B motorized dampers shall be indexed to closed.

2) When motorized dampers MD-03 and MD-09 have fully opened and MD-04A, MD-04B, MD-10A and MD-10B have fully closed, as proven by the damper motor end switches, RTU-1 shall run under its own local control sequence. Refer to Section 23 74 16 - Packaged, Rooftop Air-Conditioning Units.

3) When the HVAC local control panel EB-HLCP-02 receives an off signal from RTU-1, RTU-1 shall shut down and MD-03 and MD-09 shall close.

h. RTU-1 Manual Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector for RTU-1 in the MANUAL position, the rooftop air conditioning unit shall be started by pushing the START button.

2) Upon pushing the START button, MD-03 and MD-09 motorized dampers shall be indexed to open, MD-04A, MD-04B, MD-10A and MD-10B motorized dampers shall be indexed to closed.

3) When motorized dampers MD-03 and MD-09 have fully opened and MD-04A, MD-04B, MD-10A and MD-10B have fully closed, as proven by the damper motor end switches, RTU-1 shall run under its own local control sequence. Refer to Specification Section 23 74 16 - Packaged, Rooftop Air-Conditioning Units.

4) With the MANUAL/AUTO selector for RTU-1 in the MANUAL position. Upon pushing the STOP push button, the rooftop air conditioning unit RTU-2 shall immediately stop and MD-03 and MD-09 shall close.

i. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

1) Supply fans SAF-1 and SAF-2 shall be interlocked to exhaust fans EAF-1 and EAF-2.

2) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to prevent supply and exhaust fans running while rooftop air conditioning unit is running.

3) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to prevent both supply fans or both exhaust fans running simultaneously.

4) A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

5) An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

6) An airflow switch shall be provided in the ductwork near the inlet of each exhaust fan and near the discharge of each supply fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

7) In the event of a fault with all supply fans, all exhaust fans and rooftop air conditioning concurrently, an alarm shall be

made at the LCP and MD-01 and MD-02 shall be indexed open to allow minimal cooling from MV Switchgear Room HVAC system.

8) If space temperature rises 2 degrees F (adjustable) above cooling setpoint for a 10-minute (adjustable) time period, a signal from the room thermostat shall generate a visual alarm at the local control panel EB-HLCP-02.

9) If space temperature drops 2 degrees F (adjustable) below heating setpoint for a 10-minute (adjustable) time period, a signal from the room thermostat shall generate a visual alarm at the local control panel EB-HLCP-02.

10) The local control panel EB-HLCP-02 shall monitor dry contact provided by the rooftop air conditioning unit manufacturer. A visual alarm shall be generated at EB-HLCP-02 upon system alarm/trouble.

11) The local control panel EB-HLCP-02 shall monitor dry contact from each fan, provided by the fan unit manufacturer. A visual alarm shall be generated at EB-HLCP-02 upon system alarm/trouble.

12) The local control panel EB-HLCP-02 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at EB-HLCP-02 in the event of an over temperature condition.

j. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

k. Remote Controls: The Contractor shall furnish, install and connect a remote room thermostat as indicated.

54. MV Switchgear Room HVAC System Control

a. The MV Switchgear Room is served by supply and exhaust fans, in duty/standby configuration, to provide mechanical ventilation to maintain space setpoint. When it is not possible to meet space setpoints through mechanical ventilation, a rooftop air conditioning unit provides the necessary heating or cooling.

b. The supply fans and rooftop air conditioning unit share the same supply air distribution ductwork and require motorized dampers to isolate the inactive equipment. Likewise, the exhaust fans and rooftop air conditioning unit share the same return air distribution ductwork and require motorized dampers to isolate the inactive equipment.

c. The MV Switchgear Room HVAC system setpoints are as follows:

1) Cooling setpoint = 95 degrees F (adjustable)

2) Heating setpoint = 60 degrees F (adjustable)

d. Logic within the HVAC Local Control Panel EB-HLCP-01 shall be provided to operate the fans and rooftop air conditioning unit as follows:

1) If outside air dry bulb temperature is greater than 85 degrees F or space temperature is less than 60 degrees F:

a) EAF-3, EAF-4, SAF-3 and SAF-4 are disabled

b) RTU-2 operates in automatic mode

2) If outside air dry bulb temperature is less than or equal to 85 degrees F and space temperature is greater than or equal to 60 degrees F:

a) EAF-3, EAF-4, SAF-3 and SAF-4 operate in automatic mode

b) RTU-2 is disabled

e. EAF-3, EAF-4, SAF-3 and SAF-4 Automatic Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector in the AUTO position, supply fans SAF-3 and SAF-4 shall be interlocked to exhaust fans EAF-3 and EAF-4.

2) When the panel mounted selector switches for EAF-3, EAF-4, SAF-3 and SAF-4 are in the AUTO position, motorized dampers MD-06A, MD-06B, MD-08A and MD-08B shall be indexed to closed. The fans shall be started and stopped by the room thermostat.

3) When the LCP receives a signal to start fans, MD-06A and MD-08A shall be indexed to open, MD-05 and MD-07 shall be indexed to closed.

4) When motorized dampers MD-06A and MD-08A have fully opened and MD-05 and MD-07 have fully closed as proven by their damper motor end switches, SAF-3 supply fan and EAF-3 exhaust fan shall start and run continuously.

5) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the supply fans SAF-3 and SAF-4, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

6) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the exhaust fans EAF-3 and EAF-4, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

f. EAF-3, EAF-4, SAF-3 and SAF-4 Manual Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector switch of the fan in the MANUAL position, the fan shall be started by pushing the START button.

2) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to only allow one supply fan to operate at a time to prevent damage to the supply ductwork system.

3) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to only allow one exhaust fan to operate at a time to prevent damage to the exhaust ductwork system.

4) Upon pressing the START push button, the motorized damper corresponding to the fan shall be indexed to open, MD-05 and MD-07 shall be indexed to closed.

5) When the motorized damper corresponding to the fan is fully opened and MD-05 and MD-07 have fully closed as proven by their damper motor end switches, fan shall start.

6) Selecting the STOP push button will cause the fan to stop immediately and close the motorized damper corresponding to the fan.

g. RTU-2 Automatic Operation (via Manual-Auto Selector Switch):

1) When the panel mounted selector switch for RTU-2 is in the AUTO position, and the HVAC local control panel EB-HLCP-01 receives a run signal from RTU-2, MD-05 and MD-07 motorized dampers shall be indexed to open, MD-06A, MD-06B, MD-08A and MD-08B motorized dampers shall be indexed to closed.

2) When motorized dampers MD-05 and MD-07 have fully opened and MD-06A, MD-06B, MD-08A and MD-08B have fully closed, as proven by the damper motor end switches, RTU-2 shall run under its own local control sequence. Refer to Section 23 74 16 - Packaged, Rooftop Air-Conditioning Units.

3) When the HVAC local control panel EB-HLCP-01 receives an off signal from RTU-2, RTU-2 shall shut down and MD-05 and MD-07 shall close.

h. RTU-2 Manual Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector for RTU-2 in the MANUAL position, the rooftop air conditioning unit shall be started by pushing the START button.

2) Upon pushing the START button, MD-05 and MD-07 motorized dampers shall be indexed to open, MD-06A, MD-06B, MD-08A and MD-08B motorized dampers shall be indexed to closed.

3) When motorized dampers MD-05 and MD-07 have fully opened and MD-06A, MD-06B, MD-08A and MD-08B have fully closed, as proven by the damper motor end switches, RTU-2 shall run under its own local control sequence. Refer to Specification Section 23 74 16 - Packaged, Rooftop Air-Conditioning Units.

4) With the MANUAL/AUTO selector for RTU-2 in the MANUAL position. Upon pushing the STOP push button, the rooftop air conditioning unit RTU-2 shall immediately stop and MD-05 and MD-07 shall close.

i. Electric Unit Heater Operation

1) Each electric unit heater shall be provided with an internal adjustable thermostat. The internal thermostat shall stop or start the fan to maintain room conditions at the set point.

2) The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

3) All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

4) Electric unit heater is intended for standby heating in event that the rooftop air conditioning units are out of service or do not meet the space heating setpoint. Each EUH-3 shall activate or deactivate heating element automatically, to maintain space temperature heating setpoint.

a) MV Switchgear Room heating setpoint shall be 60 degrees F (adjustable).

j. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

1) Supply fans SAF-3 and SAF-4 shall be interlocked to exhaust fans EAF-3 and EAF-4.

2) Logic within the HVAC Local Control Panel EB-HLCP-01 shall be provided to prevent supply and exhaust fans running while rooftop air conditioning unit is running.

3) Logic within the HVAC Local Control Panel EB-HLCP-01 shall be provided to prevent both supply fans or both exhaust fans running simultaneously.

4) A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

5) An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

6) An airflow switch shall be provided in the ductwork near the inlet of each exhaust fan and near the discharge of each supply fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

7) In the event of a fault with all supply fans, all exhaust fans and rooftop air conditioning concurrently, an alarm shall be made at the LCP and MD-01 and MD-02 shall be indexed open to allow minimal cooling from Unit Substation Room HVAC system.

8) If space temperature rises 2 degrees F (adjustable) above cooling setpoint for a 10-minute (adjustable) time period, a signal from the room thermostat shall generate a visual alarm at the local control panel EB-HLCP-01.

9) If space temperature drops 2 degrees F (adjustable) below heating setpoint for a 10-minute (adjustable) time period, a signal from the room thermostat shall generate a visual alarm at the local control panel EB-HLCP-01.

10) The local control panel EB-HLCP-01 shall monitor dry contact provided by the rooftop air conditioning unit manufacturer. A visual alarm shall be generated at EB-HLCP-01 upon system alarm/trouble.

11) The local control panel EB-HLCP-01 shall monitor dry contact from each fan, provided by the fan unit manufacturer. A visual alarm shall be generated at EB-HLCP-01 upon system alarm/trouble.

12) The local control panel EB-HLCP-01 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at EB-HLCP-01 in the event of an over temperature condition.

k. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

l. Remote Controls: The Contractor shall furnish, install and connect a remote room thermostat as indicated.

TITLE: ELECTRICAL BUILDING BATTERY ROOM HVAC SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-903, KSEB-H-907

EQUIPMENT: RTU-3, RTU-4 (standby), EAF-7, EAF-8 (standby), EUH-1 (standby), MD-15, MD-16, MD-17, MD-18, MD-19, MD-20

CONTROL PANEL: EB-HLCP-03

DESCRIPTION:

55. Rooftop Air Conditioning Units

a. The rooftop air conditioning units shall be controlled via room thermostat and controller furnished by the unit manufacturer. The units shall operate in a duty/standby configuration. In the event of a running unit fault, the designated standby unit shall automatically start.

56. Electric Unit Heaters

a. Each electric unit heater shall be provided with an internal adjustable thermostat. The internal thermostat shall stop or start the fan to maintain room conditions at the set point.

b. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

c. All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

57. Exhaust Fans

a. An exhaust fan shall run continuously to limit the buildup of hydrogen concentration in the Battery Room. The fans shall operate in a duty/standby configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

58. Normal Operation:

a. Rooftop air conditioning unit controller shall enable/disable fan and stage compressors as needed to maintain space temperature cooling and heating setpoints.

1) Battery Room RTU cooling setpoint shall be 80 degrees F (adjustable).

2) Battery Room RTU heating setpoint shall be 62 degrees F (adjustable).

b. Electric unit heater is intended for standby heating in event that the rooftop air conditioning units are out of service or do not meet the space heating setpoint. EUH-1 shall activate or deactivate heating element automatically, to maintain space temperature heating setpoint.

1) Electrical Room heating setpoint shall be 60 degrees F (adjustable).

c. Exhaust Fan Automatic Operation (via Manual-Auto Selector Switch)

1) With the MANUAL/AUTO selector in the AUTO position, exhaust fans EAF-7 and EAF-8 shall be interlocked to motorized dampers MD-19 and MD-20.

2) When the panel mounted selector switches for EAF-7 and EAF-8 are in the AUTO position, motorized dampers MD-19 and MD-20 shall be indexed to closed.

3) When the LCP receives a signal to start fans, MD-19 and MD-20 shall be indexed to open.

4) When motorized dampers MD-19 and MD-20 have fully opened as proven by their damper motor end switches, EAF-7 exhaust fan shall start and run continuously.

5) Logic within the HVAC Local Control Panel EB-HLCP-03 shall be provided to operate the exhaust fans EAF-7 and

EAF-8, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

6) Logic within the HVAC Local Control Panel EB-HLCP-03 shall be provided to operate the fans in automatic operation based on a field adjustable building occupancy schedule.

7) When the HVAC local control panel EB-HLCP-03 receives an off signal from EAF-7 or EAF-8, the respective fan shall shut down and MD-19 and MD-20 shall close.

59. Exhaust Fan Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector for EAF-7 or EAF-8 in the MANUAL position and upon pressing the START push button, motorized dampers MD-19 and MD-20 shall index to open.

b. The fan shall start upon confirmation from the other fan's airflow switch that the other fan is off and when motorized dampers MD-19 and MD-20 have fully opened as proven by their damper motor end switches. Pushing the OFF pushbutton will cause the fan to stop immediately and motorized dampers MD-19 and MD-20 to close.

60. Alarms

a. If space temperature rises 2 degrees F (adjustable) above cooling setpoint for a 10-minute (adjustable) time period, the rooftop air conditioning unit's controller shall generate a visual alarm at the local control panel EB-HLCP-03.

b. If space temperature drops 2 degrees F (adjustable) below EUH-1 heating setpoint for a 10-minute (adjustable) time period, the electric unit heater shall generate a visual alarm at the local control panel EB-HLCP-03.

c. The local control panel EB-HLCP-03 shall monitor dry contact provided by the rooftop air conditioning unit manufacturer. A visual alarm shall be generated at EB-HLCP-03 upon system alarm/trouble.

d. The local control panel EB-HLCP-03 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at EB-HLCP-03 in the event of an over temperature condition.

e. EAF-7 exhaust fan shall be interlocked with EAF-8 in a duty/standby configuration.

f. Exhaust fans EAF-7 and EAF-8 shall be interlocked with motorized dampers MD-19 and MD-20.

g. An airflow switch shall be provided in the ductwork near the discharge of each fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

61. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

62. Fan Rotational Program: the Contractor shall program a fan rotational program based on hours of operation to balance wear and tear between duty and standby fans.

TITLE: ELECTRICAL BUILDING SECURITY ROOM VENTILATION SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-902, KSEB-H-908

EQUIPMENT: EAF-5, MD-11, MD-12, SD-01, SD-02

CONTROL PANEL: EB-HLCP-04

DESCRIPTION:

63. Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector for EAF-5 in the MANUAL position and upon pressing the START push button, motorized dampers MD-11 and MD-12 shall index to open.

b. The fan shall start upon confirmation when motorized dampers MD-11 and MD-12 have fully opened as proven by their damper motor end switches. Pushing the OFF pushbutton will cause the fan to stop immediately and motorized dampers MD-11 and MD-12 to close.

64. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector in the AUTO position, EAF-5 shall be interlocked with MD-11 and MD-12.

b. Logic within the HVAC Local Control Panel EB-HLCP-04 shall be provided to operate the fans in automatic operation based on a field adjustable building occupancy schedule.

c. When the HVAC local control panel EB-HLCP-04 receives an off signal from EAF-5, the fan shall shut down.

65. Clean Agent System Shutdown:

a. Fan shall shut down in any mode upon signal from the clean agent system control panel.

b. All smoke dampers, SD-01 and SD-02, shall close in any mode upon signal from the clean agent system control panel.

66. Post-Event Clean Agent Release Purge:

    a. Purge mode shall be activated by purge switch at clean agent system control panel to allow the room to be purged entirely of clean agent after a discharge has occurred.

    b. When purge mode activated by purge switch, SD-01, SD-02, MD-11 and MD-12 shall be opened by signal from clean agent system control panel. Upon confirmation from end switches that dampers are open, EAF-5 exhaust fan shall operate in purge mode until purge switch deactivated.

67. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

    a. EAF-5 exhaust fan shall be interlocked with MD-11 and MD-12.

    b. Clean agent system control panel shall have shutdown control of the equipment in all modes.

    c. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

    d. An airflow switch shall be provided in the ductwork near the discharge of each fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

68. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: ELECTRICAL BUILDING COMMUNICATIONS ROOM VENTILATION SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-902, KSEB-H-908

EQUIPMENT: EAF-6, MD-13, MD-14, SD-03 and SD-04

CONTROL PANEL: EB-HLCP-04

DESCRIPTION:

69. Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for EAF-6 in the MANUAL position and upon pressing the START push button, motorized dampers MD-13 and MD-14 shall index to open.

    b. The fan shall start upon confirmation when motorized dampers MD-13 and MD-14 have fully opened as proven by their damper motor end switches. Pushing the OFF pushbutton will cause the fan to stop immediately and motorized dampers MD-13 and MD-14 to close.

70. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector in the AUTO position, EAF-6 shall be interlocked with MD-13 and MD-14.

    b. Logic within the HVAC Local Control Panel EB-HLCP-04 shall be provided to operate the fans in automatic operation based on a field adjustable building occupancy schedule.

    c. When the HVAC local control panel EB-HLCP-04 receives an off signal from EAF-6, the fan shall shut down.

71. Clean Agent System Shutdown:

    a. Fan shall shut down in any mode upon signal from the clean agent system control panel.

    b. All smoke dampers, SD-03 and SD-04, shall close in any mode upon signal from the clean agent system control panel.

72. Post-Event Clean Agent Release Purge:

    a. Purge mode shall be activated by purge switch at clean agent system control panel to allow the room to be purged entirely of clean agent after a discharge has occurred.

    b. When purge mode activated by purge switch, SD-03, SD-04, MD-13 and MD-14 shall be opened by signal from clean agent system control panel. Upon confirmation from end switches that dampers are open, EAF-6 exhaust fan shall operate in purge mode until purge switch deactivated.

73. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

    a. EAF-6 exhaust fan shall be interlocked with MD-13 and MD-14.

    b. Clean agent system control panel shall have shutdown control of the equipment in all modes.

    c. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

    d. An airflow switch shall be provided in the ductwork near the discharge of each fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

74. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: ELECTRICAL BUILDING HEAT PUMP SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-902, KSEB-H-908

EQUIPMENT: ACU-1, ACU-2, ACCU-1, ACCU-2

CONTROL PANEL: EB-HLCP-04

DESCRIPTION:

75. Each indoor heat pump unit shall be controlled via room thermostat and controller furnished by the unit manufacturer.

76. Normal Operation:

    a. Heat pump unit controller shall enable/disable fan and stage compressors as needed to maintain space temperature cooling and heating setpoints.

        1) Security Room setpoints (adjustable):

            a) Cooling setpoint shall be 80 degrees F

            b) Heating setpoint shall be 60 degrees F

        2) Communications Room setpoints (adjustable):

            a) Cooling setpoint shall be 80 degrees F

            b) Heating setpoint shall be 60 degrees F

77. Clean Agent System Shutdown:

    a. Indoor units ACU-1 and ACU-2 shall shut down in any mode upon signal from the clean agent system control panel.

    b. Outdoor units ACCU-1 and ACCU-2 shall shut down in any mode upon signal from the clean agent system control panel.

78. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

    a. Leak detection for ceiling cassette indoor heat pump units shall be provided by the Contractor. If water sensor detects presence of water, a visual alarm shall be generated at the local control panel PB-HLCP-04 and the ceiling cassette indoor unit shall shutdown.

    b. Clean agent system control panel shall have shutdown control of the equipment in all modes.

TITLE: ELECTRICAL BUILDING FIRE SUPPRESSION ROOM HEATING AND VENTILATION SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-903, KSEB-H-908

EQUIPMENT: EAF-9, MD-21, MD-22, EUH-2

CONTROL PANEL: EB-HLCP-04

DESCRIPTION:

79. Electric Unit Heater

a. Each electric unit heater shall be provided with an internal adjustable thermostat. The internal thermostat shall stop or start the fan to maintain room conditions at the set point.

b. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

c. All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

80. Exhaust Fans

a. An exhaust fan shall run continuously to purge the Fire Suppression Room of clean agent in the event of a leak from the clean agent tanks in the room.

81. Normal Operation:

a. Electric unit heater EUH-2 shall activate or deactivate heating element automatically, to maintain space temperature heating setpoint.

1) Fire Suppression Room heating setpoint shall be 60 degrees F

b. Exhaust Fan Automatic Operation (via Manual-Auto Selector Switch)

1) With the MANUAL/AUTO selector in the AUTO position, exhaust fan EAF-9 shall be interlocked to motorized dampers MD-21 and MD-22.

2) When the panel mounted selector switch for EAF-9 is in the AUTO position, motorized dampers MD-21 and MD-22 shall be indexed to closed.

3) When the LCP receives a signal to start fans, MD-21 and MD-22 shall be indexed to open.

4) When motorized dampers MD-21 and MD-22 have fully opened as proven by their damper motor end switches, EAF-9 exhaust fan shall start and run continuously.

5) Logic within the HVAC Local Control Panel EB-HLCP-04 shall be provided to operate the fan in automatic operation based on a field adjustable building occupancy schedule.

6) When the HVAC local control panel EB-HLCP-04 receives an off signal from EAF-9, the fan shall shut down and MD-21 and MD-22 shall close.

82. Exhaust Fan Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector for EAF-9 in the MANUAL position and upon pressing the START push button, motorized dampers MD-21 and MD-22 shall index to open.

b. The fan shall start upon confirmation when motorized dampers MD-21 and MD-22 have fully opened as proven by their damper motor end switches. Pushing the OFF pushbutton will cause the fan to stop immediately and motorized dampers MD-21 and MD-22 to close.

83. Alarms

a. The local control panel EB-HLCP-03 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at EB-HLCP-03 in the event of an over temperature condition.

b. Exhaust fan EAF-9 shall be interlocked with motorized dampers MD-21 and MD-22.

c. An airflow switch shall be provided in the ductwork near the intake of the fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

84. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

3.03 FIELD TESTING / QUALITY CONTROL

Not used.

3.04 STARTUP / DEMONSTRATION

Not used.

3.05 ADJUSTING / PROTECTION / CLEANUP

Not used.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 22 05 17 – Sleeves and Sleeve Seals for HVAC Piping

B. Section 22 05 18 – Escutcheons for HVAC Piping

C. Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment

D. Section 23 05 53 – Identification for HVAC Piping and Equipment

E. Section 23 07 19 – HVAC Piping Insulation

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. Section includes pipe and fitting materials and joining methods for the following:

1. Copper tube and fittings.

2. Joining materials.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of the following:

a. Pipe.

b. Fittings.

c. Joining materials.

2. Delegated-Design Submittal:

a. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.

b. Locations of pipe anchors and alignment guides and expansion joints and loops.

c. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

d. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

B. Informational Submittals

1. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

a. Suspended ceiling components.

b. Other building services.

c. Structural members.

2. Qualification Data: For Installer.
3. Welding certificates.
4. Field quality-control reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Copper Tube and Fittings
1. Copper or Bronze Pressure-Seal Fittings:
a. Nibco
b. Mueller Industries, Inc.
c. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Copper Tube and Fittings
1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).
2. Copper or Bronze Pressure-Seal Fittings:
a. Housing: Copper.
b. O-Rings and Pipe Stops: EPDM.
c. Tools: Manufacturer's special tools.
d. Minimum 200-psig working-pressure rating at 250 deg F.
3. Wrought-Copper Unions: ASME B16.22.

B. Joining Materials
1. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

3. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Piping Applications

1. Condensate-Drain Piping: Type M (Type C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Piping Installations

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

2. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

3. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

4. Install piping at indicated slopes.

5. Install piping free of sags and bends.

6. Install fittings for changes in direction and branch connections.

7. Install piping to allow application of insulation.

8. Select system components with pressure rating equal to or greater than system operating pressure.

9. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

10. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
11. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
12. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
13. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
14. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
15. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for identifying piping.
16. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
17. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

C. Installation of Hangers and Support

1. Comply with requirements in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
2. Install the following pipe attachments:
    a. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
3. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
    a. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
    b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
    c. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
    d. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    e. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    f. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
    g. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

4. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

D. Pipe Joint Construction

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

3.03 FIELD TESTING / QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7

times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 22 05 17 – Sleeves and Sleeve Seals for Plumbing Piping

B. Section 22 05 18 – Escutcheons for Plumbing Piping

C. Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment

D. Section 23 05 53 – Identification for HVAC Piping and Equipment

E. Section 23 07 19 – HVAC Piping Insulation

1.04 REFERENCES

A. ASHRAE 15 - Safety Standard for Refrigeration Systems

B. ASME B31 – Pressure Piping

1.05 DESCRIPTION

A. Section Includes:

1. Refrigerant pipes and fittings.

2. Refrigerant piping valves and specialties.

3. Refrigerants.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of valve, refrigerant piping, and piping specialty.

2. Include pressure drop, based on manufacturer's test data, for the following:

a. Thermostatic expansion valves.

b. Solenoid valves.

c. Hot-gas bypass valves.

d. Filter dryers.

e. Strainers.

f. Pressure-regulating valves.

3. Shop Drawings:

a. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.

b. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between

compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

4. Show interface and spatial relationships between piping and equipment.

5. Shop Drawing Scale: 1/4 inch equals 1 foot.

B. Informational Submittals

1. Welding certificates.

2. Field quality-control reports.

C. Closeout Submittals

1. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Copper Tube and Fittings

1. Copper Pressure-Seal Fitting for Refrigerant Piping:

a. Conex Banninger – USA

b. Parker Hannifin, Sporlan Division

c. RLS LLC

d. Or approved equal.

B. Valves and Specialties

1. Diaphragm Packless Valves

a. Danfoss Inc.

b. Heldon Products

c. Parker Hannifin Corp.

d. Or approved equal

2. Packed-Angle Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved equal
3. Check Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved Equal
4. Service Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved equal
5. Solenoid Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved equal
6. Safety Relief Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved equal
7. Thermostatic Expansion Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Paul Mueller Company
   d. Or approved equal

8. Hot-Gas Bypass Valves
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
9. Straight-Type Strainers
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
10. Angle-Type Strainers
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
11. Moisture/Liquid Indicators
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
12. Replaceable-Core Filter Dryers
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
13. Permanent Filter Dryers
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
14. Mufflers

a. Danfoss Inc.
b. Heldon Products
c. Emerson Climate Technologies
d. Or approved equal

15. Receivers
a. Heldon Products
b. Or approved equal

16. Liquid Accumulators
a. Danfoss Inc.
b. Heldon Products
c. Parker Hannifin Corp.
d. Or approved equal

C. Refrigerants
1. ASHRAE 34, R-410A:
a. Arkema Inc.
b. DuPont Fluorochemicals Div.
c. Genetron Refrigerants
d. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Performance Requirements
1. Line Test Pressure for Refrigerant R-410A:
a. Suction Lines for Air-Conditioning Applications: 300 psig.
b. Suction Lines for Heat-Pump Applications: 535 psig.
c. Hot-Gas and Liquid Lines: 535 psig.

B. Copper Tube and Fittings
1. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B).
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
5. Brazing Filler Metals: AWS A5.8/A5.8M.

6. Flexible Connectors:
    a. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
    b. End Connections: Socket ends.
    c. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
    d. Working Pressure Rating: Factory test at minimum 500 psig.
    e. Maximum Operating Temperature: 250 deg F.
7. Copper Pressure-Seal Fittings for Refrigerant Piping:
    a. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
    b. Housing: Copper.
    c. O-Rings: HNBR or compatible with specific refrigerant.
    d. Tools: Manufacturer's approved special tools.
    e. Minimum Rated Pressure: 700 psig.

C. Valves and Specialties
1. Diaphragm Packless Valves:
    a. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
    b. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
    c. Operator: Rising stem and hand wheel.
    d. Seat: Nylon.
    e. End Connections: Socket, union, or flanged.
    f. Working Pressure Rating: 500 psig.
    g. Maximum Operating Temperature: 275 deg F.
2. Packed-Angle Valves
    a. Body and Bonnet: Forged brass or cast bronze.
    b. Packing: Molded stem, back seating, and replaceable under pressure.
    c. Operator: Rising stem.
    d. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
    e. Seal Cap: Forged-brass or valox hex cap.

f. End Connections: Socket, union, threaded, or flanged.

g. Working Pressure Rating: 500 psig

h. Maximum Operating Temperature: 275 deg F

3. Check Valves

a. Body: Ductile iron, forged brass, or cast bronze; globe pattern.

b. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.

c. Piston: Removable polytetrafluoroethylene seat.

d. Closing Spring: Stainless steel.

e. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.

f. End Connections: Socket, union, threaded, or flanged.

g. Maximum Opening Pressure: 0.50 psig.

h. Working Pressure Rating: 500 psig.

i. Maximum Operating Temperature: 275 deg F.

4. Service Valves

a. Body: Ductile iron, forged brass, or cast bronze; globe pattern.

b. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.

c. Piston: Removable polytetrafluoroethylene seat.

d. Closing Spring: Stainless steel.

e. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.

f. End Connections: Socket, union, threaded, or flanged.

g. Maximum Opening Pressure: 0.50 psig.

h. Working Pressure Rating: 500 psig.

i. Maximum Operating Temperature: 275 deg F.

5. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

a. Body and Bonnet: Plated steel.

b. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

c. Seat: Polytetrafluoroethylene.

d. End Connections: Threaded.

e. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.

f. Working Pressure Rating: 400 psig

g. Maximum Operating Temperature: 240 deg F

6. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

a. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

b. Piston, Closing Spring, and Seat Insert: Stainless steel.

c. Seat: Polytetrafluoroethylene.

d. End Connections: Threaded.

e. Working Pressure Rating: 400 psig.

f. Maximum Operating Temperature: 240 deg F.

7. Thermostatic Expansion Valves: Comply with AHRI 750.

a. Body, Bonnet, and Seal Cap: Forged brass or steel.

b. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

c. Packing and Gaskets: Non-asbestos.

d. Capillary and Bulb: Copper tubing filled with refrigerant charge.

e. Suction Temperature: 40 deg F.

f. Superheat: Adjustable.

g. Reverse-flow option (for heat-pump applications).

h. End Connections: Socket, flare, or threaded union.

i. Working Pressure Rating: 700 psig

8. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

a. Body, Bonnet, and Seal Cap: Ductile iron or steel.

b. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

c. Packing and Gaskets: Non-asbestos.

d. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

e. Seat: Polytetrafluoroethylene.

f. Equalizer: Internal.

g. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter and 24-V ac coil.

h. End Connections: Socket.

i. Set Pressure: adjustable.

j. Throttling Range: Maximum 5 psig.

k. Working Pressure Rating: 500 psig.

l. Maximum Operating Temperature: 240 deg F.

9. Straight-Type Strainers

a. Body: Welded steel with corrosion-resistant coating.

b. Screen: 100-mesh stainless steel.

c. End Connections: Socket or flare.

d. Working Pressure Rating: 500 psig.

e. Maximum Operating Temperature: 275 deg F

10. Angle-Type Strainers

a. Body: Forged brass or cast bronze.

b. Drain Plug: Brass hex plug.

c. Screen: 100-mesh monel.

d. End Connections: Socket or flare.

e. Working Pressure Rating: 500 psig.

f. Maximum Operating Temperature: 275 deg F

11. Moisture/Liquid Indicators

a. Body: Forged brass.

b. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.

c. Indicator: Color coded to show moisture content in parts per million (ppm).

d. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

e. End Connections: Socket or flare.

f. Working Pressure Rating: 500 psig.

g. Maximum Operating Temperature: 240 deg F

12. Replaceable-Core Filter Dryers
    a. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
    b. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
    c. Desiccant Media: Activated charcoal
    d. Designed for reverse flow (for heat-pump applications).
    e. End Connections: Socket.
    f. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
    g. Maximum Pressure Loss: 2 psig.
    h. Rated Flow: based on installed equipment capacities.
    i. Working Pressure Rating: 500 psig.
    j. Maximum Operating Temperature: 240 deg F.
13. Permanent Filter Dryers: Comply with AHRI 730.
    a. Body and Cover: Painted-steel shell.
    b. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
    c. Desiccant Media: Activated charcoal
    d. Designed for reverse flow (for heat-pump applications).
    e. End Connections: Socket.
    f. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
    g. Maximum Pressure Loss: 2 psig.
    h. Rated Flow: based on installed equipment capacities.
    i. Working Pressure Rating: 500 psig.
    j. Maximum Operating Temperature: 240 deg F
14. Mufflers
    a. Body: Welded steel with corrosion-resistant coating.
    b. End Connections: Socket or flare.
    c. Working Pressure Rating: 500 psig.

d. Maximum Operating Temperature: 275 deg F

15. Receivers: Comply with AHRI 495.

a. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

b. Comply with UL 207; listed and labeled by an NRTL.

c. Body: Welded steel with corrosion-resistant coating.

d. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.

e. End Connections: Socket or threaded.

f. Working Pressure Rating: 500 psig.

g. Maximum Operating Temperature: 275 deg F

16. Liquid Accumulators

a. Body: Welded steel with corrosion-resistant coating.

b. End Connections: Socket or threaded.

c. Working Pressure Rating: 500 psig.

d. Maximum Operating Temperature: 275 deg F

D. Refrigerants

1. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Piping Applications for Refrigerant R-410A

1. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

2. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3. Safety-Relief-Valve Discharge Piping NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Valve and Specialty Applications

1. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

2. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

3. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

4. Install a full-size, three-valve bypass around filter dryers.

5. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

6. Install thermostatic expansion valves as close as possible to distributors on evaporators.

7. Install valve so diaphragm case is warmer than bulb.

8. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

9. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

10. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

11. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

12. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

    a. Solenoid valves.

    b. Thermostatic expansion valves.

    c. Hot-gas bypass valves.

    d. Compressor.

13. Install filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor.

14. Install receivers sized to accommodate pump-down charge.

15. Install flexible connectors at compressors.

C. Piping Installation

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

2. Install refrigerant piping according to ASHRAE 15.

3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

6. Install piping adjacent to machines to allow service and maintenance.

7. Install piping free of sags and bends.

8. Install fittings for changes in direction and branch connections.

9. Select system components with pressure rating equal to or greater than system operating pressure.

10. Refer to Section 23 09 00 - Instrumentation and Controls Scope and General Requirements, Section 23 09 13 - Instrumentation and Control Devices for HVAC” and Section 23 09 93 - Sequence of Operations for HVAC" for solenoid valve controllers, control wiring, and sequence of operation.

11. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

12. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

13. Install refrigerant piping in protective conduit where installed belowground.

14. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

15. Slope refrigerant piping as follows:

a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

b. Install horizontal suction lines with a uniform slope downward to compressor.

c. Install traps and double risers to entrain oil in vertical runs.

d. Liquid lines may be installed level.

16. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

17. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

18. Identify refrigerant piping and valves according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

19. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

20. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

21. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

D. Pipe Joint Construction

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

5. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.

6. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

7. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded

pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

8. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.

9. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

10. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Installation of Hangers and Supports

1. Comply with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment - for hangers, supports, and anchor devices.

2. Install the following pipe attachments:

a. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

b. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.

d. Spring hangers to support vertical runs.

e. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

3. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

4. Support horizontal piping within 12 inches of each fitting.

5. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.03 FIELD TESTING / QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

   a. Fill system with nitrogen to the required test pressure.

   b. System shall maintain test pressure at the manifold gage throughout duration of test.

   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.04 STARTUP / DEMONSTRATION

A. System Charging

1. Charge system using the following procedures:

   a. Install core in filter dryers after leak test but before evacuation.

   b. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

   c. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

   d. Charge system with a new filter-dryer core in charging line.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

E. Open shutoff valves in condenser water circuit.

F. Verify that compressor oil level is correct.

G. Open compressor suction and discharge valves.

H. Open refrigerant valves except bypass valves that are used for other purposes.

I. Check open compressor-motor alignment and verify lubrication for motors and bearings.

J. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all ductwork complete with auxiliary equipment and accessories as shown, specified and/or required for proper operation.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment

C. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

D. Section 23 07 13 – Duct Insulation

E. Section 23 09 13 – Instrumentation and Control Devices for HVAC

1.04 REFERENCES

A. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

B. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

1. HVAC Duct Construction Standards.

2. Seismic Restraint Manual - Guidelines for Mechanical Systems.

D. ASTM E437 Industrial Wire Cloth and Screens (Square Opening Series)

E. UL 555 - Fire Dampers.

F. UL 555S – Smoke Dampers, Combination Fire and Smoke Dampers

G. UL 181 - Factory Made Air Ducts and Connectors.

H. UL 214 - Tests for Flame Propagation of Fabrics and Films.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the ductwork.

2. Engage a firm which can show successful experience in the fabrication and erection for ductwork systems of scope and type similar to the required Work.

B. Installer Qualifications:

1. Contractor shall have at least 5 years' experience in the installation of the Work specified. He shall employ only tradesmen with specific skills and experience in this type of Work.

2. Contractor shall have undivided responsibility as a single firm for performance and other requirements for the installation of the Work specified herein.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.

1. Underwriters Laboratories, Incorporated (UL)
2. National Fire Protection Association (NFPA).
3. National Electrical Code.
4. Local and State Building Codes and Ordinances:
   a. New York City Building Code.
   b. New York State Uniform Fire Prevention and Building Code.
5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. 1/4-inch scale duct layouts.
2. Dimensions.
3. Details of construction.
4. Details of installation, hanger details and spacing.
5. Manufacturer's literature, illustrations, specifications and Engineering data.
6. Registers, grilles and diffusers.
7. Fire Dampers (UL Listed):
   a. Closing mechanisms.
   b. Fusible link operating temperature.
   c. Installation details.
   d. Access Doors.
8. Smoke Dampers (UL Listed):
   a. Closing mechanisms.
   b. Installation details.
   c. Access Doors.
9. Combination Fire and Smoke Dampers (UL Listed):
   a. Closing mechanisms.
   b. Installation details.
   c. Access Doors.
10. Flexible connections.

11. Other technical data related to the specified material and equipment as requested by Engineer.

12. Duct sealants.

13. Air outlet schedule indicating room name and location of each outlet. Cross reference Contract designation and manufacturer's model number or name.

B. Test Reports: Submit the following test reports for approval where required.

1. UL Label, Fire Dampers, Smoke Dampers, Combination Fire and Smoke Dampers.

2. Volume Damper leakage tests from an AMCA-approved testing laboratory.

C. Contractor shall provide certification that all stainless steel accessories including screws, hangers, supports, etc. for stainless steel, are Type 316 stainless steel.

D. Certification: Manufacturer shall provide certified test data.

E. The Contractor shall submit details of construction to the Engineer for review

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools necessary to service, disassemble, repair and adjust the materials and products provided under this Section, and as per the requirements of the Contract Documents. In addition, furnish the following spare parts:

1. Twelve (12) spare fusible links.

B. Tools: Provide standard and special tools and supplies necessary to service, disassemble, repair and adjust the products.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ductwork Accessories for Transverse Duct Connections shall be Ductmate 35® System as manufactured by Duct Mate Industries Inc., Charleroi, PA or approved equal.

B. Volume Dampers as manufactured by Ruskin Company, Grandview, MO or approved equal.

C. Rectangular fire dampers as manufactured by Air Balance, Inc., Wyalusing, PA or approved equal.

D. Air Volume Extractors as manufactured by Hart and Cooley, Grand Rapids, MI, Titus, Plano, TX or approved equal.

E. Registers, Grilles, and Diffusers: Supply Registers, Air Turning Devices, Exhaust and Return Registers and/or Grilles as manufactured by A-J Manufacturing Co., Inc., Kansas City, MO or approved equal.

F. Transfer Grilles as manufactured by A-J Manufacturing Co., Inc., Kansas City, MO or approved equal.

2.02 MATERIALS / EQUIPMENT

A. General:

1. All work shall be constructed and installed properly in accordance with the recommendations given in the latest edition of the Sheet Metal & Air Conditioning Contractors National Association (SMACNA) HVAC Duct Construction Standards and Rectangular Industrial Duct Construction Standards.

2. All ductwork shall be constructed in accordance with the Schedule of Metal Duct Construction Standards, located after the "End of Section" designation. The transverse duct connections shall be bolted, gasketed connections made with standard Ductmate 35 System.

3. All ducts shall conform accurately to the dimensions indicated on the Contract Drawings, shall be straight and smooth on the inside with neatly finished joints, and shall not be decreased at any point to avoid obstructions. No piping, conduit or structural work shall be installed in or through any ductwork. All ductwork shall be run as close as possible to structural members, walls and ceilings. Ductwork shall be as shown on the Contract Drawings, subject to such modifications as may be necessary to suit field conditions to clear any obstruction or conflicts with other equipment.

4. Where existing walls, floors or roofs must be penetrated, Contractor shall neatly cut the required openings and patch the existing work to provide a neat and finished appearance.

B. Metal Ductwork:

1. Stainless Steel (Type 316 stainless steel): All ductwork shall be constructed of Type 316 stainless steel except as specified below and shown on the Contract Drawings.

a. All accessories, air outlets, hardware, and fasteners shall be Type 316 stainless steel unless otherwise noted.

2. Galvanized Steel (G90 Coating): Only where specified on the Contract Drawings.

a. Air devices for galvanized ductwork shall be aluminum.

3. Aluminum (with 3003 ductwork H-14 alloy and temper): Only where specified on the Contract Drawings.

a. Air devices and ductwork accessories for aluminum ductwork shall be aluminum.

C. Stainless Steel Ductwork:

1. Stainless steel duct sheet thicknesses shall be two gauge heavier than the thickness specified in SMACNA standards for galvanized steel duct.

2. Flanged duct joints shall be 0.25-in Butyl gasketed and bolted together with stainless steel (Type 316) bolts, nuts, washers and lock washers. All duct joints shall be airtight.

3. All accessories including but not limited to, registers, grilles, diffusers, turning vanes, air turning devices, manual volume dampers, motor operated control dampers, fire dampers, and access doors installed in stainless steel ductwork shall be fabricated of the same stainless steel material as the associated ductwork. Supports, angles, clamps and hardware shall be Type 316 stainless steel.

4. Schedule:

a. All ductwork shall be fabricated and installed in accordance with the Schedule of Metal Duct Construction Standards, located after the "End of Section" designation.

b. Duct constructed of fiberglass duct board shall not be permitted on the job except where specifically specified.

D. Ductwork Accessories

1. Hangers and Supports:

a. All ductwork shall be securely hung and anchored to the building structure. Unless otherwise shown or specified, hangers and stiffeners for ducts shall conform to the recommendations given in the SMACNA HVAC Duct Construction standards and SMACNA seismic restraint manual. Ducts shall be supported on trapeze hangers with angles or rods. Use of strap hangers and straps is prohibited.

b. All ductwork shall be supported from trapeze type hangers. Hanger rods shall be minimum 3/8 inch for all ducts with half perimeter up to 72 inches, and ½ inch diameter for all ducts with half perimeter larger than 72 inches. A pair of rods shall be provided at each duct support point.

c. Maximum hanger spacing shall be 8 feet for ducts with half perimeter up to 72 inches and 6 feet for ducts with half perimeter larger than 72 inches.

d. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall be Type 316 stainless steel except for galvanized steel ductwork may be galvanized steel.

e. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.

f. Support shall be furnished at each fitting.

g. Seismic Requirements:

1) All piping and ductwork shall be provided with seismic restraints in accordance with the Seismic Restraint Manual, guidelines for Mechanical Systems dated 1991, as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) and in accordance with the New York City Building Code and referenced Uniform Building Code requirements.

2) Piping and ductwork shall be supported to withstand seismic forces anticipated in seismic zones 2A.

h. Conform to all requirements of Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

2. Sleeves: Where ductwork passes through masonry walls, partitions or floors provide minimum 16 gauge, Type 316 stainless steel for stainless steel, and aluminum ductwork, and galvanized steel for galvanized ductwork. Caulk airtight with fire resistant sealant between sleeve and ductwork.

3. Volume Dampers:

a. Volume dampers shall comply with SMACNA Standards.

b. Material: As specified for ductwork.

c. Blades: Opposed blades, vinyl edge seals.

d. Provide outside handle, quadrant and approved position indicator and locking device.

e. Performance:

1) Damper Leakage: Not more than 16 cfm per square foot at 4-inch W.G.

4. Control Dampers:

a. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

b. Frames:

1) Angle shaped.

2) 0.094-inch- thick, galvanized sheet steel.

3) Mitered and welded corners.

c. Blades:

1) Multiple blade with maximum blade width of 6 inches.

2) Parallel-blade design.

3) Galvanized-steel.

4) 0.064 inch thick single skin.

d. Blade Edging: Closed-cell neoprene.

e. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1) Operating Temperature Range: From minus 40 to plus 240 deg F.

f. Bearings:

1) Molded synthetic.

2) Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

3) Thrust bearings at each end of every blade.

g. Actuator: comply with requirements as required by Section 23 09 13 – Instrumentation and Control Devices for HVAC.

5. Smoke Dampers:

a. General Requirements: Label according to UL 555S by an NRTL.

b. Smoke Detector: Integral, factory wired for single-point connection.

c. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

d. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- thick, galvanized sheet steel.

e. Leakage: Class III.

f. Rated pressure and velocity to exceed design airflow conditions.

g. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.

h. Actuator:

1) Type: Electric 120 V, 60 Hz, two-position, fail close or Electric 24V, 60 Hz, two-position, fail close.

2) Mounting: External (out of air stream).

i. Accessories:

1) Indicator or Auxiliary Switch Package: Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.

2) Actuator with internal switches: Damper “open”, damper “closed”. Switches mounted internal to actuator.

3) Factory Sleeve:

a) Minimum 20 gage (1.0 mm) thickness.

b) Minimum 12 inches (305 mm) long.

4) Damper test switch - push button.

6. Combination Fire and Smoke Dampers:

a. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

b. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

c. Fire Rating: 1-1/2 hours.

d. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

e. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.

f. Smoke Detector: Integral, factory wired for single-point connection.

g. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- thick, galvanized sheet steel.

h. Leakage: Class III.

i. Rated pressure and velocity to exceed design airflow conditions.

j. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.

k. Master control panel for use in dynamic smoke-management systems.

l. Actuator:

1) Type: Electric 120 V, 60 Hz, two-position, fail close or Electric 24V, 60 Hz, two-position, fail close.

2) Mounting: External (out of air stream).

m. Accessories:

1) Indicator or Auxiliary Switch Package: Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.

2) Actuator with internal switches: Damper “open”, damper “closed”. Switches mounted internal to actuator.

3) Factory Sleeve:

a) Minimum 20 gage (1.0 mm) thickness.

b) Minimum 12 inches (305 mm) long.

4) Damper test switch - push button.

7. Self-acting Dampers

a. Self-acting dampers shall be of the adjustable, counter-balanced type and shall be fabricated blades set in frame.

b. Materials:

1) Self-acting dampers and frames installed in the stainless steel ductwork shall be of Type 316 stainless steel.

2) Self-acting dampers and frames installed in aluminum and galvanized steel ductwork shall be aluminum.

8. Fire Dampers (Dynamic Type):

a. Fire Dampers:

1) Fusible Link Fire Dampers and access doors shall be provided where indicated on the Contract Drawings and

where required by local codes. Fire dampers shall be of the curtain type with interlocking blades set in a one piece frame, and shall be suitable for installation in the vertical or horizontal position. The dampers shall conform to all requirements of the latest edition of the National Fire Code NFPA 90A and shall have a 1-1/2 or 4 hour standard fire protection rating in accordance with UL555, "Standard for Fire Dampers." Fire dampers installed in Type 316 stainless steel, aluminum, and fiberglass ductwork shall be fabricated of Type 316 stainless steel and shall be provided with vacuum formed springs. All fusible links shall be UL rated at 165°F.

b. Label:

1) All fire dampers shall have UL Label attached and galvanized steel construction for galvanized steel ductwork. Type 316 stainless steel construction for aluminum, stainless steel ductwork.

2) Label shall have a fire rating of, at a minimum:

a) 1-1/2 hours for fire separations (walls, floors and partitions) rated at 2 hours.

b) 3 hours for walls, floors and partitions rated at 3 hours and above.

3) All fire dampers shall be Dynamic Rated for closure against airflow in the following six installation configurations:

a) Vertical Mount (Horizontal Airflow): Ducted and unducted.

b) Horizontal Mount (Airflow Up): Ducted and unducted.

c) Horizontal Mount (Airflow Down): Ducted and unducted.

4) Each fire damper proposed shall be rated to close against maximum design airflow at its installed location with a 10 percent safety factor and against 8 in. w.g. maximum pressure across the closed damper.

c. Two fire dampers rated at 1-1/2 hours each, one on each face of the fire separation or fire division, are required for fire separations having a 3-hour fire rating or above as per local code.

d. Type: Galvanized steel blades for galvanized ductwork and Type 316 stainless steel blades for aluminum, stainless steel and FRP ductwork with interlocking joints and fusible links.

e. Provide firestopping at fire separations where fire dampers are installed.

f. Provide an access door in duct at each fire damper located in duct.

9. Sheet Metal Safing:

a. Provide aluminum sheet metal safing to close off and seal airtight all unused areas behind louvers.

b. Insulation shall be 2 inch thick fiberglass, permanently attached to sheet metal. Safing shall consist of a two inch thick rigid fiberglass board type insulation sandwiched between two 16 gauge minimum sheets.

c. Insulation shall be secured to the sheets with adhesive.

d. All edges of the panels shall be provided with a 16 gauge minimum channel secured in place with sheetmetal screws six inches on centers.

e. Insulated sandwich panels shall be removable type with maximum space of 18 inches, and supported on 3 x 3 x ¼" angle. Provide intermediate supports.

f. The sheets, channels and hardware used for the safing shall be 316 stainless steel.

10. Access Doors:

a. Comply with SMACNA HVAC Duct Construction Standards.

b. Type: Gasketed cam lock covers.

c. Materials: Same as duct.

d. Unless otherwise specified access doors shall be:

1) 12 by 6 inches for ducts sizes 12-inches and smaller.

2) 12 by 12-inches for ducts size 14-inches.

3) 21 by 14-inches for ducts between 14 and 36 inches.

4) 25 by 17 inches for ducts between 36 and 60 inches.

5) Two 25 by 17 inch doors for ducts larger than 61 inches.

e. Access doors for fire dampers shall be stenciled "FIRE DAMPER ACCESS" with minimum ½-inch high letters.

11. Flexible Connections:

a. Comply with SMACNA Standards for pressure classification of 3 inches water gage.

b. Material (unless otherwise specified):

1) Minimum 1/16-inch thick, 6-inch wide reinforced butyl or EPDM sheeting.

2) 16 gauge, 3-inch wide galvanized steel strip for galvanized steel ductwork. Type 316 stainless steel for stainless steel ductwork.

3) 0.080 thick 3-inch wide aluminum strip for aluminum ductwork.

12. Turning Vanes:

a. Reference: SMACNA HVAC Duct Construction Standard.

b. Material: Same material as ductwork.

c. Vanes: Double thickness.

13. Air Volume Extractors:

a. Reference: SMACNA HVAC Duct Construction Standard.

b. Material: Same material as ductwork.

c. Blades: Gang-operated curved adjustable blades controlled through manual adjusting lever.

14. Gravity Backdraft Dampers (located in ductwork):

a. Construction:

1) Multiple, interlocked blades mounted in frame.

2) Felt gasketed blade edges.

3) Stainless steel or brass bearings.

4) Tie rod connecting each blade.

5) Counterweights or adjustable spring attached to tie rods.

6) Metal frame.

b. Materials:

1) Same material as ductwork.

2) Tie Rod: Aluminum 0.081 gage.

3) Louver Arm: Aluminum 0.081 gage.

4) Bumpers: Waterproof felt.

15. Hardware:

a. All fastening devices used for aluminum, stainless steel, and ductwork shall be Type 316 stainless steel.

b. All gasketing material shall be butyl.

16. Metallic Flexible Duct:

a. Metallic type duct shall be single-ply Type 316 stainless steel.

b. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to ½ duct diameter.

c. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of minimum 5 inches water gauge at 250°F.

d. Runout length shall be limited to 10 feet and size limited to 8 inch in diameter.

17. Insulated Nonmetallic Flexible Duct Runouts:

a. Flexible duct runouts shall be used only where indicated on the Contract Drawings.

b. Runout length shall be as shown on the Contract Drawings, but shall in no case exceed 10 feet in length and 8 inch in diameter. Runouts shall be pre-insulated, factory fabricated, and shall comply with NFPA 90A and UL 181.

c. Either field or factory applied vapor barrier shall be provided.

d. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands.

e. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods.

f. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL-01.

18. High Temperature Service Duct Connections

a. Material shall be approximately 3/32 inch thick, 35 to 40-ounce per square yard weight, and plain weave fibrous glass cloth with nickel/chrome wire reinforcement for service in excess of 1200°F.

19. Air Vents and Goosenecks:

a. Air vents and goosenecks shall be fabricated from the material as specified for ductwork with structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to SMACNA-06.

b. Air vents and goosenecks shall be provided with bird screen.

20. Bird Screens and Frames: (Type 316 Stainless Steel):

a. Bird screens shall conform to ASTM E437, Type I, Class 1, 2 by 2 mesh, 0.031 inch diameter stainless steel wire.

b. Frames shall be removable type stainless steel construction.

E. Registers, Grilles and Diffusers

1. General:

a. Units shall be factory-fabricated of Type 316 stainless steel construction for stainless steel ductwork; aluminum construction when installed in aluminum and galvanized steel ductwork, and shall distribute the specified of air volume (cubic feet per minute).

b. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70.

c. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers.

d. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen according to NFPA 90A.

e. Diffusers:

1) Diffuser types shall be as indicated.

2) Diffusers shall be provided with air deflectors of the type indicated.

3) Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL-03 for the interchangeable use as cooled or heated air supply diffusers or return air units.

4) Ceiling mounted units shall be installed with rims tight against ceiling.

5) Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers.

6) Return or exhaust units shall be similar to supply diffusers.

f. Registers and Grilles:

1) Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face.

2) Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling.

3) Grilles shall be as specified for registers, without volume control damper.

g. An additional volume damper shall be installed in duct stub to each air outlet for balancing of air volume.

2. Supply registers shall be complete with adjustable vertical face bars and a key operated opposed blade damper. Supply registers installed in stainless steel ductwork shall be of Type 316 stainless steel double deflection type complete with opposed blade stainless steel damper and aluminum construction when installed in aluminum or galvanized steel ductwork.

3. Air turning devices shall be installed at all collar take-offs to supply registers.

a. The air turning devices shall have two sets of individually adjustable blades to equalize flow and control volume at collar takeoffs and shall be gasketed around the perimeter.

4. Return and exhaust registers shall be complete with fixed vertical face bars, set straight, and a key operated opposed blade damper. Return and exhaust registers and damper installed in stainless steel ductwork shall be of Type 316 stainless steel with opposed blade stainless steel damper and aluminum when installed in aluminum or galvanized steel ductwork.

5. Exhaust shall be complete with fixed vertical face bars, set straight. Return and exhaust grilles installed in stainless steel ductwork shall be of Type 316 stainless steel construction, and aluminum when installed in aluminum and galvanized steel ductwork.

6. Supply and return/exhaust diffusers shall be square plaque type, with round necks and integral volume dampers. And shall be entirely fabricated of Type 316 stainless steel construction when installed in stainless steel ductwork and aluminum construction when installed in aluminum or galvanized steel ductwork. Where required, and as indicated on the Contract Drawings, the

Contractor shall provide blank off baffles to eliminate drafts caused by nearby obstructions. Diffuser face shall be 24" x 24" except where indicated different size on plans. Diffusers installed in hung ceilings shall be provided with anti-smudge ring.

7. Supply Air Drum Louvers:

   a. Supply air drum louvers shall be with a felt seal around the rotating drum to prevent leakage. The louver shall be adjustable to direct the air stream at any angle up to 30 degree from the louver centerline either by rotating the drum or by adjusting the position of the pivoted vanes.

   b. Materials:

      1) Stainless steel construction in stainless steel ductwork.

      2) Aluminum in construction aluminum and galvanized steel ductwork.

8. Transfer Grille Assembly: Wall mounted grilles shall consist of two (2) grilles, installed flushed to each side of wall. A fire damper shall be installed between the grilles when located in fire rated walls. The fire damper shall consist of a fully adjustable, key operated opposed blade damper with a spring loaded fusible link assembly Type 316 stainless steel construction. The fusible link shall be UL rated at 160F. The entire assembly shall conform to the latest edition of the National Fire Code No. 90A. All transfer grille assembly shall be Type 316 stainless steel. Transfer grilles shall be as manufactured by:

9. Linear Bar Diffusers:

   a. Linear Bar Diffusers shall have 1/8 inch thick fixed bars at 0 degree deflection, spaced ½ inch on center, or approved equal. Linear bar diffusers shall be available in standard one-piece lengths up to 6 feet and shall have the sizes and mounting types shown on the plans. Diffuser lengths greater than 6 feet shall be furnished in multiple sections and will be joined together end-to-end with alignment strips or pins to form a continuous appearance. All alignment components shall be provided by the manufacturer.

   b. The diffuser core shall have extruded aluminum bars locked into a heavy extruded aluminum border. The deflection bars shall be fixed and parallel to the long dimension. The core shall have support bars located no more than 9 inches apart and shall be parallel to the short dimension.

   c. Heavy gauge extruded aluminum end borders and mitered corners shall be available to close off the ends of the diffusers. Opposed

blade damper shall be constructed of heavy gauge aluminum. Damper must be operable from the face of the diffuser.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Stainless Steel Ductwork

1. All stainless steel ductwork shall be shop fabricated in sections with welded flanged ends.

2. No field welding of ductwork shall be permitted.

3. Welding equipment and electrodes shall be of a type specifically suited for welding light gauge Type 316 stainless steel to provide consistently good quality welds.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.

3.02 INSTALLATION

A. Turning vanes shall be installed in all miter elbows to permit air to make the abrupt turns with a minimum of turbulence. The turning vanes shall be quiet and free from vibration when the system is in operation. Turning vanes shall be double thickness type. Vanes shall be installed in all short radius elbows in accordance with SMACNA standards and Industrial Duct Construction standards. Duct clean out doors shall be provided at each elbow with turning vanes.

B. Manual volume dampers larger than 11" in any dimension shall be opposed blade type. The damper blades shall be operated by a lockable dial regulator and may be set in any position. The dial regulators shall be marked so that the "open" and "shut" positions are clearly identified. The dial regulators on insulated ductwork shall be mounted on an elevated platform which will finish flush with the surface of the insulation. Manual volume dampers shall be located at accessible points and wherever possible some distance from a duct transition or fitting. Care shall be taken during installation to make certain that sheet metal fasteners do not protrude into the duct and interfere with damper operation. Dampers shall be provided in each branch duct take off and in both ducts downstream of each trunk duct split. Manual volume dampers shall be Type 316 stainless steel construction in stainless steel ductwork and aluminum construction in aluminum and galvanized steel ductwork.

C. Splitter type dampers shall not be installed.

D. Duct access doors shall be provided within working distance of, and on the fusible link side of all fire dampers, smoke dampers, combination fire and smoke dampers, adjacent to volume dampers, on the linkage side of automatic dampers and at all other apparatus requiring service or inspection in the duct system. The doors shall be rigid and airtight, and provided with neoprene gaskets, hinges and sash locks. Whenever space requirements are such that a hinged access door is impractical, a screw fastened lift-out door shall be provided instead.

E. Access doors in finished Work such as walls, plaster, wood paneling and in suspended ceilings which do not have removable panels, shall be provided for all concealed valves, controls, test openings, duct access doors, and at all other locations requiring service, inspection or adjustment of a concealed item. The Contractor shall submit details of construction and material to the Engineer for review. In general, the access doors shall match the appearance of the finished Work in which they are installed and shall be of sufficient size to permit service, inspection or adjustment of the concealed item.

F. Test openings

1. Test openings shall be sealed by a screw cap and gasket, and shall be installed so that the insulation is not disturbed when the cover is removed.

2. The test openings shall be located as follows in all heating, ventilating, air conditioning systems:

a. In the outside air duct adjacent to the unit.

b. In the exhaust air duct adjacent to the unit.

c. In the main supply duct on each unit.

G. Flexible connections for preventing the transmission of vibrations through the ductwork to the structure shall be installed between the ductwork and all air moving equipment and at the building joints. Flexible connections shall be neoprene-impregnated fabric collars with cemented seams fastened with straps and bolts of the same material as the ductwork. Flexible connections shall not be painted or used to correct misalignment. The fire damper, smoke damper or combination fire and smoke damper shall be secured to a stainless-steel collar with ¼" diameter stainless steel nuts and bolts with maximum spacing of 12 inches on center and a minimum of two fastenings per side beginning two inches from the corners of the collar. The collars shall be at least the same gauge as the ductwork to which it is attached; regardless of the duct gauge, collars shall not be lighter than 24 gauge 316 stainless steel. Retaining angles shall be installed on four sides of the collar and on both sides of the protected opening with a minimum of one inch overlap on the wall or floor. The 316 stainless steel angles shall be a minimum of 1½" x 1½" x 1/8" and shall be fastened to the collar only; do not fasten angles to the wall or floor.

H. The angles shall be fastened to the collar with ¼" diameter stainless steel nuts and bolts with a maximum spacing of 6 inches on center and a minimum of two fastenings per side beginning two inches from the corners of the collar. Where gas tight seals are required, the angles shall be fastened to the collar with a continuous weld and a sealant shall be installed between the angle and the wall or floor. Collars, angles and hardware used with stainless steel fire dampers, smoke dampers or combination fire and smoke dampers shall be Type 316 stainless steel. Clearance for expansion is required between the collar and the opening on the top and on each vertical side. The clearance shall be 1/8 inch per lineal foot of sleeve with clearance on the sides distributed equally and all vertical clearance on the top. The retaining angles shall be increased in size to provide the minimum overlap of one inch on the wall or floor. The ductwork shall be connected to the collar on each side of the wall or floor with a breakaway connection on all four sides of the collar. The distance from the wall or floor to the breakaway connection shall not exceed 6 inches.

I. Prefabricated roof curbs shall be installed before the installation of roofing.

J. Curbs to prevent water leakage shall be provided around all floor openings. Where concrete curbs are not indicated on the Contract Drawings, provide curbs fabricated of 4" x 4" x 1/4" thick angles with welded corners. The curb shall be set in a mastic compound and securely fastened to the floor to provide a watertight installation. Curbs associated with stainless steel ductwork shall be fabricated of Type 316 stainless steel.

K. Contractor shall furnish and install sleeves for registers, grilles, and dampers mounted in the masonry, concrete plenums or shafts. Sleeves shall be 16 gage Type 316 stainless steel.

L. After the installation is completed, the Contractor shall seal all joints air tight. Sealants and tape shall have a flame spread not greater than 25 and a smoke developed rating of not over 50.

M. Safing shall be provided to seal off remaining portions of shafts and louvers which are not covered by the plenums or equipment attached to the shaft or louver.

N. All bird screens shall be Type 316 stainless steel.

O. All ductwork shall conform accurately to the dimensions shown, the ducts shall be straight and smooth inside with joints neatly finished; ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.

P. Tape and seal all joints as per SMACNA Standards.

Q. Elbows shall have a minimum centerline radius of 1-1/2 times the width of the duct. Turning vanes shall be provided at all square elbows. Turning vanes shall be double wall and shall be quiet and free from vibration when the system is in operation.

R. Provide volume dampers where indicated on the Contract Drawings and as required to facilitate accurate volume control. The duct of the damper shall be reinforced to

prevent vibration. Volume dampers specified with air devices shall be installed in addition to those shown on the Contract Drawings.

S. Fire dampers, smoke dampers and combination fire and smoke dampers shall be provided and installed where indicated on the Drawings and where required by UL and authorities having jurisdiction, and shall be approved by local building codes and in accordance with the requirements of the NFPA.

T. Provide access doors for all dampers for inspection and maintenance.

U. Install all ductwork and accessories to provide a system free from buckling, warping, breathing or vibration. Flexible Connections:

1. All expansion joints in ducts at building expansion joints shall be suitably supported at each end by support guides within 12 inches of joint.

2. All ducts at flexible connections with air handling equipment, and fans shall be supported at free end within 12 inches of flexible connection.

3. Provisions shall be made for supporting all ductwork, dampers, and other ductwork accessories, where necessary.

V. Coordinate all air outlets for compatibility with ceiling system.

W. All ductwork shall arrive on Site fully fabricated, not in two halves for field fabricated.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. ADJUSTMENT

1. Set volume control devices for approximate positions in preparation for final testing and balancing.

2. Install fusible links in fire dampers and verify that dampers are in open position.

3. Start fan system and check for excessive leaks and vibration and correct.

B. BALANCING

1. Systems shall be completely tested, adjusted and balanced by a qualified Engineer. A complete balancing procedure shall be submitted for approval. All equipment and connections required to balance the systems shall be provided.

2. All duct systems shall be balanced as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

C. CLEANING

1. Remove all loose materials and obstructions from interior of ducts.

2. Remove debris and waste materials resulting from installation.

D. PAINTING

1. Surface Preparation and Shop Painting:

   a. Clean and prime coat ferrous metal surfaces of equipment in the factory/shop in accordance with the requirements of Section 09 91 00 - Painting.

   b. Coat polished and non-ferrous metal surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operations.

2. Field Painting: Painting required for exterior surfaces of ductwork and insulation, and finish painting of items only primed at the factory, are specified in Section 09 91 00 - Painting.

END OF SECTION

SCHEDULE

1. Schedule 23 31 14-1 - Metal Duct Construction Standards:

Service	Pressure Classification	Construction Standards
All ductwork on fan discharge side	4" W.G. POS.	SMACNA HVAC Duct Construction Standards
All ductwork on suction side	3" W.G. NEG.	SMACNA HVAC Duct Construction Standards
Transfer air duct not connected to fan	1" W.G. POS. or NEG.	SMACNA HVAC Duct Construction Standards

a. Notes: All accessories, including but not limited to, turning vanes, air turning devices, manual volume dampers, motor operated control dampers, fire dampers, smoke dampers, combination fire and smoke dampers, access doors, supports, angles, clamps, hangers and hardware, shall be suitable for the pressure classification given above.

1) Non-metallic ductwork shall be constructed as specified in Section 23 31 17 - Non-Metal Ducts and Accessories

2. Ductwork Material Schedule:

As shown on the Contract Drawings

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals to furnish and install all fans in accordance with the requirements specified herein, as shown on the Contract Drawings, or specified in the Contract Documents.

B. The equipment shall be furnished complete with all accessories, special tools, spare parts, base attachments, mountings, anchor bolts and other appurtenances as specified or as may be required for a satisfactory installation.

C. All fans shall be furnished in accordance with the schedule shown on the Contract Drawings.

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 23 05 48.13 - Vibration Controls for HVAC

C. Section 23 05 53 – Identification for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

E. Section 26 05 91 - Low Voltage Electric Motors

1.04 REFERENCES

A. Equipment shall comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. American Society of Mechanical Engineers (ASME)
2. American Society of Testing Materials (ASTM)
3. Air Movement and Control Association (AMCA)
4. National Electric Code (NEC)
5. The National Fire Code (NFC)
6. Applicable Federal, State and local laws and/or ordinances

B. Where conflict arises between the local codes and the requirements of the National Electrical Code, The National Fire Code, NEMA, ASTM, etc., the more stringent requirements shall prevail.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

B. It is the intent of these Specifications that all components of the fans be provided by the Contractor through one vendor. The Contractor through the vendor shall have the sole responsibility of matching all components and providing equipment which functions together as a system.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings for the approval of the Engineer. Submittals shall include, but not be limited, to the following:

1. Preliminary Operation and Maintenance Manuals
2. Final Operation and Maintenance Manuals
3. Spare Parts List

4. Special Tools List
5. Reports of Certified Shop Tests
6. AMCA Approval for Fan Ratings
7. Shop drawings shall include but not be limited to:
    a. Equipment Specifications and data sheets identifying all materials used and methods of fabrication.
    b. Complete assembly, layout, installation and foundation drawings with clearly marked dimensions.
    c. Fan performance curve indicating the operating point.
    d. Details of corrosion resistance coating.
    e. Motor nameplate data as specified in Section 26 05 19 Low Voltage Electric Motors.
    f. Contract Documents and data sheets for all accessories such as roof curbs, dampers, damper operators disconnect switches, vibration isolators etc.
    g. Example equipment nameplate data sheet.
    h. Interconnecting wiring diagrams.
    i. List of recommended lubricants.

B. Operations and Maintenance Manuals

1. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements of this Contract. Two copies of a preliminary O&M manual shall be included in the Shop Drawing submittal. Without inclusion of these manuals, the submittal will be considered incomplete and will be returned without review.

C. Lubricants: The manufacturer shall submit a list with a minimum of four (4) manufacturers' standard lubricants which may be used interchangeably for each type of lubricant required. The Contractor shall utilize this list in preparing his comprehensive lubrication survey.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Furnish all special tools necessary to disassemble, service, repair and adjust the equipment.

B. The following spare parts shall be furnished for up to every four (4) same size of fan:

1. One (1) blower with wheel

2. One (1) set bearing and seal
3. One (1) set sheave
4. One (1) shaft
5. Two (2) sets of belts for each belt driven fan

C. Furnish all additional spare parts as recommended by the equipment manufacturers.

D. Spare parts lists, included with the Shop Drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Model SP, Model BSQ, Model SQ, Model RBCF, Model GB, Model TAUB, Model USF, Model CUBE and Model CSP as manufactured by Greenheck, Schofield, WI.

B. Type BAF as manufactured by Twin City Fan & Blower, Plymouth, MN.

C. Model A88 as manufactured by Hartzell Air Movement, Piqua, OH.

D. Barry Blower Type AxiFlo as manufactured by Vaneaxial Upblast, Dayton, OH.

E. Series VR-500 and Series P-413 as manufactured by Heresite, Manitowoc, WI.

F. Loren Cook Co., Springfield, MO

G. Series AWD as manufactured by AWB, Powder Springs, GA.

H. Model VTF Roof Ventilator as manufactured by Aerovent, Minneapolis, MN

I. Air Plastics, Inc., Avon Lake, OH

J. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. FANS - CONDITION OF SERVICE AND DESIGN DATA

1. Fans shall be as specified below and shown on the Contract Drawings. The Contractor shall include, as part of this Work, all supports required. The fans shall be installed where indicated on the Contract Drawings.

2. Performance data for all fans shall be based on tests conducted in accordance with the "Standard Test Code for Centrifugal and Axial Fans" as adopted by the Air Movement and Control Association (AMCA) and shall be licensed to bear the AMCA certified rating seal for both sound and air performance. All fans shall be selected from performance curves and not from rating tables. A copy of the curve, indicating the operating point, shall be submitted for each proposed fan.

3. Unless otherwise indicated, motors shall be of the totally enclosed premium efficiency type. Motors shall not be selected for operation in the service factor range/zone. The maximum brake horsepower required at any point on the performance curve shall not exceed the rated horsepower of the motor.

4. Motors 1/3 HP and less shall be suitable for use with 115V, single phase, 60 Hz electric service. Motors 1/2 HP or larger shall be for use with 460V, three phase, 60 Hz electric service, unless otherwise indicated. Two speed motors shall be two winding type. Motors shall comply with the requirements of Section 26 05 91 – Low Voltage Electric Motors.

5. All fans and damper operators shall each be provided with individual externally mounted disconnect switches. All enclosures shall be NEMA 4X-stainless steel unless otherwise specified.

6. All dampers for roof mounted fans shall be mounted in the mounting pedestal with removable access panel for inspection and servicing of damper and operator. Mounting pedestal shall provide solid ventilator support and a weather tight seal.

7. All fans shall be statically and dynamically balanced at the speed at which the unit is scheduled to operate. Fans with corrosion resistant coatings shall be balanced after being coated.

8. The fans shall be either direct connected or V-belt drive as indicated on the schedule. For motors less than or equal to 10 HP, the V-belt drive shall be selected for 120 percent of rated capacity. For motors larger than 10 HP, the V-belt drive shall be selected for 150 percent of rated capacity. All V-belt drives shall be provided with adjustable sheaves. Exposed V-belt drives shall have removable belt guards with openings to allow for tachometer readings at both drive and fan shafts. Guards shall be so constructed as to allow visual inspection of the belts without removing the guard.

9. Vibration isolators shall be provided in conformance with Section 23 05 48.13 - Vibration Controls for HVAC. Isolators shall have a minimum efficiency of 90 percent. Installation, type, number, and size of isolators shall be in conformance with the manufacturer's recommendations for the frequencies involved.

10. Where indicated on the schedule, explosion proof motors, and AMCA Type A spark resistant construction shall be provided. Fans handling explosive

gases shall have all parts in contact with gas fabricated of non-ferrous materials; bearings shall not be located in the gas stream. Explosion proof fans shall be provided with NEMA 7 explosion proof disconnect switches, explosion proof damper operators, and explosion proof motors.

11. All fan bearings shall be selected for a minimum L-50 life of 100,000 hours at maximum operating speed.

12. All fans shall be provided (inside and outside) with baked on Heresite corrosion resistant coating including all accessories but not limited to the housing, wheels, curbs, liners, dampers, damper access sections.

13. All fan motors shall be provided with high premium energy efficient totally enclosed fan cooled type. Where indicated on the schedule, explosion proof motors and AMCA Type "A" spark resistant construction fans shall be provided.

14. All shafts shall be sized so the first critical speed is at least 20 percent over the maximum operating speed. Close tolerance shall be maintained along the length of the shaft.

15. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

16. Fan manufacturer shall provide sound power ratings in the eight octave bands. Sound power levels shall be based on AMCA Standard 301. Sound power ratings shall be in decibels, referenced to 10-12 watts.

B. IN-LINE CABINET FANS

1. Ceiling mounted exhaust fans shall be of the centrifugal direct or belt drive type. The fan housing shall be constructed of heavy gauge galvanized steel. The housing interior shall be lined with 1/2" acoustical insulation. The outlet duct collar shall include an aluminum backdraft damper and shall be adaptable for horizontal or vertical discharge.

2. The access for wiring shall be external. The motor disconnect shall be externally mounted. The motor shall be mounted on vibration isolators. The fan wheel(s) shall be of the forward curved centrifugal type, constructed of galvanized steel and dynamically balanced.

3. Direct drive fans shall be provided with solid state speed control as required.

C. CENTRIFUGAL BASE MOUNTED FANS

1. Centrifugal base mounted utility fan shall be airfoil bladed single inlet centrifugal fans.

2. Fans shall be arrangement of No. 9, V-belt driven for floor mounting. Fans shall be of all aluminum construction conforming to AMCA "B" spark resistant construction. Unit shall be electrically grounded in the field by installing Contractor. All hardware shall be Type 316 stainless steel.

3. Wheels to have aluminum back plate, shroud and airfoil blades. Adjustable drive assemblies to have static resistant belts sized with 1.5 service factor on motor horsepower. Provide unit with all aluminum belt guard. Adjustable motor mounting base to be fabricated of 316 stainless steel. Fan bearings to be provided with aluminum lubrication lines extended to a common point on the bearing stand.

4. Fans shall be provided with access door, companion flange, motor operated dampers, and inlet boxes.

5. Stainless steel parts to be mill finish.

6. Fans shall be provided with housed spring type vibration isolation for a minimum of 95 percent isolation efficiency and having spring assemblies with rubber coated springs.

7. The bearing supports shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings, bearings shall be heavy duty, self-aligning pillow block ball bearings, and grease lubricated. Shafts shall be turned, ground, polished and rust protected.

D. IN-LINE SQUARE CENTRIFUGAL FANS

1. In-line square fans shall be of centrifugal belt driven in-line type. The fan housing shall be of the square design constructed of heavy gauge all aluminum and shall include square duct mounting collars.

2. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.

3. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

4. Motors and drives shall be mounted out of the airstream with combination motor cover and belt guards. Motors shall be readily accessible for maintenance.

5. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings.

6. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for system balancing.

E. UP-BLAST ROOF MOUNTED CENTRIFUGAL FANS

1. Roof exhaust fans shall be upblast centrifugal belt driven type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and

shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. Windbands shall have a rolled bead for added strength and shall be joined to curb caps with a welded seam.

2. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

3. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

4. Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be externally mounted within NEMA 4X stainless enclosures. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.

5. Fans shall be provided with 12" high insulated prefabricated heavy gauge aluminum roof curb with liner and nailer, dampers and damper access section.

F. ROOF MOUNTED AXIAL TYPE SUPPLY FANS

1. Roof mounted supply fan shall be belt driven and axial type hooded propeller roof fans.

2. Propellers shall be constructed with cast aluminum blades and hubs. Propellers shall be securely attached to fan shafts. All propellers shall be statically and dynamically balanced.

3. Fan hood and base construction shall be aluminum. Hood panels shall be arched with interlocking ribs. Fan bases shall be tall bases. Access doors shall be provided for inspection and service of damper and actuator. Hood support angles shall be heavy gauge galvanized steel. Birdscreens of 1/2" Type 316 stainless steel mesh shall be horizontally mounted in the perimeter of the hood.

4. Drive frame and panel assemblies shall be galvanized steel. Drive frames shall be formed channels and fan panels shall have a deep formed inlet venturi.

5. Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be fully machined cast iron, keyed and securely attached to propeller and motor shafts. Motor sheaves shall be adjustable for system balancing.

6. Fans shall be provided with 12" high insulated prefabricated heavy gauge aluminum roof curb with liner and nailer, dampers and damper access section.

G. ROOF MOUNTED AXIAL TYPE EXHAUST FAN

1. Fans shall conform to the layout as shown on the drawings. Motor horsepowers and inlet and outlet velocities shall not be exceeded.

2. Fans shall be constructed of low carbon steel and painted with corrosion resistant coating. The inspection shall include welding, dimensions, bearings and overall workmanship.

3. Wheels shall be die-formed cast aluminum type.

4. Shafts shall be AISI C1045 hot rolled steel turned, ground and polished. The shaft's first critical speed shall be at least 140 percent of the fan's maximum operating speed.

5. Wheels shall be dynamically balanced, individually to ANSI S2.19, G6.3. Assembled fans shall then be dynamically balanced using a vibration analyzer to measure velocity. The final reading shall not exceed 0.1 inches per second at the fan shaft speed. The exact level of vibration will be recorded on the fan as proof of the final dynamic balance.

6. The accessories shall include, but not be limited to, belt guard, weather cover, quick open access door, drain, companion flanges, inlet screen, discharge screen, shaft seal, discharge cap, curb cap, spark resistant construction and vibration isolators in accordance with the requirements specified herein and as shown on the Contract Drawings.

7. Housings shall be constructed of heavy gauge steel, structurally reinforced and suitably braced to prevent vibration or pulsation, and shall be arc welded throughout. Lifting lugs shall be welded to the housing to facilitate handling of the fans. Straightening vanes shall be supplied on vaneaxial fans to convert the helical airflow pattern to a smooth straight flow as it leaves the wheel to improve pressure characteristics and eliminate resonant noise.

H. IN-LINE CENTRIFUGAL STAINLESS STEEL FANS

1. Fans shall be V-belt or direct driven with companion angle rings for inlet and outlet ductwork. The motor shall be mounted on a continuously welded motor base that is perpendicular to the fan housing, supported by four (4) adjustable riser bolt assemblies.

2. The fan housing shall be minimum gauge 10 commercial quality 316 stainless steel suitable for temperatures up to 200 F. The inner housing shall be totally enclosed to protect the fan bearings and belts. The inner housing shall be supported to the outer housing by means of air straightening guide vanes. The housing and the wheels shall be continuously welded in

compliance with ASME standards. All accessories exterior to the air stream shall be epoxy coated, i.e., motor base and belt guard.

3. The wheels shall be type BAF air foil industrial quality 316 stainless steel blades having non-overloading horsepower characteristics. The wheels shall be mounted to the fan shaft with a split taper bushing.

4. The shafts shall be ground and polished. Fan bearings shall be grease lubricated with external fittings. The fan bearings shall be heavy-duty, self-aligning ball or roller type depending on the fan size, motor horsepower, and performance, and relubricable for continuous service. The belts shall be oil, heat and static resistant type oversized for continuous duty. Variable pitch drives shall be provided as standard up to and including fans with 10 horsepower motors. Fans shall be complete with suspension clips or support legs as required, companion flanges and spring type vibration isolators.

I. ROOF MOUNTED CENTRIFUGAL FANS

1. Roof mounted fans shall be centrifugal belt or direct drive type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

2. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. The fan shroud shall have a rolled bead for added strength.

3. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished with the specified voltage, phase and enclosure. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance.

4. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

5. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.

6. A fan conduit chase shall be provided through the curb cap to the motor compartment for ease of installation.

7. Each fan shall bear a permanently affixed manufacturer’s nameplate containing the model number and individual serial number for future identification.

8. Fans shall be provided with 12" high insulated prefabricated heavy gauge aluminum roof curb, dampers and damper access section.

   a. For pitched standing seam metal roofing installations, fans shall be provided with base rails. Base rails mounted on structural channels provided by structural Contractor. Refer to structural drawings for mounting details.

J. TUBE AXIAL UPBLAST ROOF EXHAUST FAN

1. Roof mounted upblast exhaust fans shall be of the belt drive tube axial type.
2. Propeller construction shall be cast aluminum airfoil. A standard square key or tapered bushing shall lock the propeller to the shaft. Propellers shall be statically and dynamically balanced.
3. Fan housings shall be constructed of welded heavy gauge steel to assure no air leakage.
4. Bearing supports shall be constructed of structural steel members to prevent vibration and rigidly support the shaft and bearings. All structural steel parts shall be coated with corrosion resistant to provide a lasting finish.
5. Close tolerances shall be maintained where the shaft makes contact with the bearing. Bearings shall be heavy duty, grease lubricated, self-aligning ball type in pillow block mounts. Extended lubrication lines shall be provided with external grease fittings.
6. Windbands shall be constructed of heavy gauge steel with reinforced edges.
7. Curb caps shall be constructed of heavy gauge steel with a prepunched mounting flange and integral venturi inlet.
8. Fans shall be provided with 12" high insulated prefabricated heavy gauge aluminum roof curb, dampers and damper access section.
9. Tube axial upblast roof exhausters shall be supplied as shown on the plans and in the fan schedule.

K. TUBULAR CENTRIFUGAL INLINE DUCT FANS

1. General: Fan shall be factory assembled and tested unit complete with fan wheel, fan shaft, bearings, drive, motor and accessories as specified below. Capacity shall be as scheduled on the Contract Drawings.
2. Materials and Construction:

   a. In-line tubular centrifugal exhaust fans of all aluminum construction with straightening vanes, flanged inlet and outlet connections and support brackets for mounting. Wheel shall be air foil design, non-overloading, statically and dynamically balanced and venturi shaped intake rim. Inner tube construction welded to housing with access plate for servicing and isolation of bearings and drive from air stream.

b. Accessories for fans shall consist of hinged access doors, inlet and outlet flanges, and belt guards.

c. Fan shall have direct or V-belt drive with an adjustable pitch motor pulleys. Pulleys shall be cast steel sized for a 1.2 service factor.

d. The entire fan housing, blades, and all accessories shall be coated with minimum 3 coats (5 mil DFT).

3. Motors shall be ball bearing drive, mounted on an adjustable platform outside the air stream. Motor HP and electrical characteristics shall be as scheduled on the Contract Drawings.

4. Belt guard shall be totally enclosed. Lubrication may be oil or grease type. Integral overload protection, factory mounted and wired unfused disconnects shall be provided for all single phase motors.

L. WALL MOUNTED PROPELLER FANS

1. Type: Wall mounted, propeller fan.

2. Capacity: As specified in the Equipment Schedule on the Contract Drawings.

3. Construction: Steel Wall Fan:

a. Propellers:

1) Airfoil design.

2) Cast aluminum alloy or heavy gauge steel material.

3) Statically and dynamically balanced.

4) Six blades.

5) Propellers equipped with malleable iron split-taper bushing for alignment and locking of propeller to the shaft.

a) Bushing held in place by compression and keyed to the shaft to prevent slipping or loosening.

b) Positioned with three standard capscrews for easy assembly and disassembly.

b. Venturi and Panel:

1) Heavy gauge steel.

2) Designed for airfoil propellers.

c. Safety Guard:

1) 1/2 inch by 1/2 inch PVC coated mesh wire screen that meets OSHA standards.

2) Removable sections to provide for easy access to motor.

d. Damper: None.

4. Accessories:

   a. All structural steel used for mounting fans shall be corrosion resistant coated. Mounting hardware shall be steel.

   b. The Contractor to provide additional stiffeners, angles and supports as required to mount the fans.

5. Drive:

   a. Direct or belt drive as shown on the Contract Drawings.

   b. OSHA approved guard.

6. Painting:

   a. All external and internal metal surfaces of fans, guards, (except propellers and motors) shall be factory primed and factory painted in accordance with Section 09 90 00 - Painting and Coating.

   b. Propellers shall be factory coated with a 4 coat baked phenolic coating system minimum of 2 to 3 mils dry film thickness total.

M. FIBERGLASS AXIAL ROOF FANS

1. Type: Roof mounted, Belt drive axial fan with stack cap and butterfly gravity damper and curb base.

2. Capacity: As scheduled on the Contract Drawings.

3. Construction:

   a. Housing:

      1) Polyester resin reinforced with cloth and mat with integral flanges.

      2) The bearing, base and drive enclosure shall be supported by gussets interlocked into and taped to the outer housing. These structural parts shall all be of laminated glass and resin.

      3) All parts in contact with the air stream shall be constructed of solid fiberglass reinforced plastic using fire retardant resin.

   b. Wheel:

      1) Constructed using a hand lay-up method.

      2) Glass cloth shall be cut to various template sizes to form laminations which are to be fitted into a mold.

      3) Glass shall be impregnated with resin in a step-by-step process.

      4) The fan wheel shall be cured under pressure in the mold forming a monolithic structure.

c. Shaft:

1) Type 316 stainless steel.

2) Machined and keyed with the end drilled and tapped.

3) The wheel shall be held tightly against the shaft shoulder by a stainless steel bolt in the end of the shaft.

4) Stainless steel set screws shall be used to hold the key in place.

d. Shaft Seal:

1) The ends of the bearing and shaft enclosure shall have cover plates sealed into place with an inert silicone rubber sealant.

2) The propeller end cover plate shall be fitted with viton or butyl shaft seal and stainless steel retainer plate.

e. Bearings:

1) The bearings shall be sealed pillow block type with grease tubes extending to the outside of the fan housing.

2) The bearings, shaft and drive shall be enclosed to protect them from air stream contaminants.

f. Motor Base: A steel motor base with slide rail arrangement for belt adjustment shall be bolted between wide gussets integral with flanges of the fan housing.

g. Exterior housing of fan and all accessories shall be factory painted in accordance with Section 09 90 00 - Painting and Coating.

h. Exterior surfaces of the FRP fan, shall be factory painted with an epoxy enamel finish equal to Tnemec. Primer coat shall be Tnemec 66 Epoxoline. Finish coat shall be Tnemec 71 Endurashield. Paint shall be factory applied with touch-up painting in the field as required.

4. Drive: Direct or belt drive as shown on the Contract Drawings.

5. Prefabricated Roof Curb:

a. Weatherproof (slope base type for fans located on sloped roof) continuous welded aluminum construction.

b. Insulated with 1-1/2 inch minimum rigid board fiberglass.

c. Provide treated wood nailer on top of curb with gasket.

d. Twelve inch curb height measured from finished roof to top of wood nailer on high side of roof slope or flat roof.

e. Curb to Roof Deck Fasteners: Cadmium plated lag screws or cadmium plated bolts.

f. Refer to architectural Drawings for curb flashing details.

g. Curb shall be furnished from the same fan manufacturer.

6. Accessories: All furnished from the same fan manufacturer.

a. Stainless steel bolts and nuts.

b. Fiberglass curb base.

c. Fiberglass stack cap.

d. OSHA motor/drive cover - weatherproof.

7. Coatings: Exterior surfaces of the FRP fan, shall be factory painted with an epoxy enamel finish equal to Tnemec. Primer coat shall be Tnemec 66 Epoxoline. Finish coat shall be Tnemec 71 Endurashield. Paint shall be factory applied with touch-up painting in the field as required.

N. FIBERGLASS INLINE AXIAL FLOW DUCT FANS

1. Type: Direct or belt driven, FRP construction duct fan, as shown on the Contract Drawings.

2. Capacity: As scheduled on the Contract Drawings.

3. Construction:

a. Solid FRP construction for corrosive air handling service. Metal components to be coated with corrosion proof paint.

b. Flanged inlet and outlet connections with bolt holes. Provide viton or butyl Gaskets (minimum 1/4 inch thick) at flexible connections to fan inlet and outlet.

c. Single piece solid fiberglass wheel, minimum six blades.

d. Wheel statically and dynamically balanced.

e. Greaseable ball bearings, external grease fittings, L-10 minimum life rating of 40,000 hours at maximum rated rpm.

f. Type 316 stainless steel shaft with EPDM slinger, viton or butyl rubber seal and fiberglass coverplate.

g. Type 316 stainless steel hardware.

h. Motor mounted on fan housing, adjustable mounting. Drive compartment sealed off securely from any leakage of corrosive fumes.

i. Accessories:

1) OSHA approved belt guard.

2) Corrosion resistant coated steel mounting feet, inlet and discharge flanges with bolt holes.

4. Drive: Direct or belt drive.

5. Belt Guard: FRP cover for belt and motor, OSHA approved with tachometer hole.

6. Access Doors:

   a. Conform to housing curvature.

   b. Gasketed (viton or butyl).

7. Mounting Supports: Provide Type 316 stainless steel support brackets and hardware for fan mounting.

O. FIBERGLASS CENTRIFUGAL UPBLAST ROOF FANS

1. Type: Belt driven, FRP construction duct fan, as shown on the Contract Drawings.

2. Capacity: As scheduled on the Contract Drawings.

3. Construction:

   a. Structural parts located in the airstream shall be either fiberglass resin or epoxy coated stainless steel.

   b. All fiberglass surfaces shall be constructed of polyester resin and glass fiber with antimony trioxide added to achieve Class I flame spread below 25.

   c. All fiberglass surfaces shall be protected with a minimum 10 mil thickness of chemical, flame, and ultraviolet resin. The entire housing shall have a finish coat of resin to provide protection and smooth airflow. All airstream hardware shall be 316 stainless steel. All hardware outside the airstream shall be 316 stainless steel.

   d. Fan assembly shall be provided with veil and electric grounding.

   e. The fan housing shall be constructed of fiberglass with a rigid internal support structure.

   f. The fan wheel shall be centrifugal backward inclined, constructed of solid fiberglass to provide non-loading, efficient operation. The wheel shall have a totally encapsulated aluminum core insert for secure attachment to the shaft. The wheel shall be one-piece and suitable for temperatures up to 125 deg F.

   g. Fan shaft shall be precision ground and polished 316 stainless steel. Bearings shall be heavy-duty, self-aligning ball bearings with a minimum 50,000 hours L10 life. A neoprene shaft seal shall be placed where the shaft leaves the housing.

   h. Drive frame assembly shall be constructed of heavy gauge steel and mounted on vibration isolators.

   i. Drive:

      1) Motor pulleys shall be adjustable for final system balancing.

2) Motors and drives shall be mounted on vibration isolators, protected from the airstream.

3) Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants.

4) Motors shall be readily accessible for maintenance.

5) Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

j. Controls:

1) A disconnect switch shall be externally mounted within NEMA 4X stainless enclosures.

2) A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.

k. Accessories:

1) Fans shall be provided with an 18-inch high insulated pre-fabricated FRP wind rated roof curb with damper shelf and FRP motor operated damper assembly. Damper assembly shall be Class 1 with an air leakage rate not greater than 4 cfm per square foot of damper surface at 1.0 inch water gauge and shall be labeled by an approved agency when tested in accordance with AMCA 500D for such purpose.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. IDENTIFICATION

1. Each unit of equipment shall be identified with the equipment item numbers given on the Contract Drawings or as directed by the Engineer. A corrosion resistant tag or nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

3.02 INSTALLATION

A. The fans shall be installed, connected and placed in proper working order in accordance with the manufacturer's instructions and details, and the Contract Drawings.

3.03 FIELD TESTING / QUALITY CONTROL

A. TESTING

1. All tests shall be performed in accordance with the requirements of the Contract Documents. Motor tests in accordance with Section 26 05 91 – Low Voltage Electrical Motors.

2. Field tests shall be performed in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

B. MANUFACTURER'S REPRESENTATIVE

1. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract. The services of the manufacturer's representative shall be provided for a period indicated and as specified in the Contract Documents.

2. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Resident Engineer each day he is at the Project.

3. Training:

a. The Contractor shall provide training for City personnel. The Contractor shall include in his request for manufacturer approval a certification that the manufacturer has been advised of the stringent requirements for training, and that the costs associated with said training submittals and training have been included in the manufacturer's pricing.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified, and required to furnish, install, and test intake and relief vents, complete and operational.

B. The following index of this Section is presented for convenience:

C.

D. All air outlet and inlets shall be provided in accordance with the schedule shown on the Contract Drawings.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Not Used

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. This Section includes requirements for providing air outlets and inlets as well as accessories in accordance with applicable standards and regulations. In addition:

1. Air outlets and inlets shall be furnished complete with all accessories, special tools, spare parts, mountings, anchor bolts, and other appurtenances as specified and/or required for proper installation.

1.06 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with the applicable provisions of the standards organizations and regulatory agencies, below:

1. Underwriters Laboratories, Inc.
2. National Fire Protection Association.
3. National Electrical Code.
4. Local and State Building Codes and Ordinances:
   a. Building Code of the State of New York.
   b. New York State Uniform Fire Prevention and Building Code.
   c. New York State Energy Conservation Code.

B. Qualifications of Manufacturer:

1. All components of the air outlets and inlets shall be provided by the Contractor through a single air outlet and inlet vendor.
   a. The vendor shall engage manufacturer(s) which can show successful experience in the fabrication and manufacture of the equipment specified herein.
      1) The manufacturer(s) shall (each) have at least five (5) years' experience in the installation of Work specified.
   b. The Contractor (through the air outlet and inlet vendor), shall have the sole responsibility of matching all components and providing equipment which functions together as a system.
2. The air outlets and inlets shall be the standard equipment of the manufacturer(s).

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

B. Manufacturer's literature, illustrations, specifications, and Engineering data including:

1) Dimensions.

2) Materials of construction.

3) Details of installation.

4) Prefabricated curb details.

5) Air velocity through throat (fpm).

6) Air pressure drop through unit (in. W.G.).

b. Drawings showing:

1) The general arrangement of the equipment and methods of installation with detailed mounting information.

c. Documentation from the factory substantiating painting systems in accordance with the specifications. Include types applied and dry film thicknesses. Include color chart for color selection.

d. Operation and maintenance manuals

2. Information Submittals:

a. Spare parts list

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The cleaning, preservation and packing of the air outlets and inlets for shipment shall be in accordance with the manufacturer's commercial practice.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The air outlets and inlets shall be handled in such a manner that they may be transported and unloaded without being over-stressed, deformed, or otherwise damaged.

2. The air outlets and inlets shall be protected from corrosion and deterioration and shall be stored in a dry area.

a. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with effective and durable waterproof covers approved by the Engineer.

3. Interiors shall be kept free from dirt and foreign matter.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools necessary to service, disassemble, repair and adjust the equipment provided under this Section, and as per the requirements of the Contract Documents and/or as recommended by the manufacturer.

B. Tools: Provide standard and special tools and supplies necessary to service, disassemble, repair, and adjust the equipment.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All products provided under this Section shall be covered by a ten (10) year manufacturer warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Air outlets and inlets:

1. Multitier Louver Type TR (intake vent) and Type TRE (relief vent), as manufactured by Loren Cook Company, Powder Springs GA;
2. Model FGI (intake vent) and Model FGR (relief vent) as manufactured by Greenheck Fan Corporation, Valley Forge, PA;
3. Multitier Gravity Louvered Penthouse Ventilators, Model TIL, as manufacturer by Twin City Fan and Blower, Minneapolis, MN.
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Air Intake and Relief Vents:

1. Capacity: As shown on the Contract Drawings.
2. General:
   a. Provide low contour, rectangular or square hood type, as shown on the Contract Drawings.
   b. Provide multitier louver type as shown on the Contract Drawings.
3. Construction:
   a. Housing:
      1) Spun aluminum construction reinforced to withstand wind forces without damage.
      2) Housings for intake and relief units shall be of similar in finish and color to match roof mounted fans in appearance.
   b. Base:
      1) One-piece spun aluminum or welded aluminum construction.

B. Accessories:

1. Dampers: Opposed-blade, aluminum construction. Dampers shall be Motor Operated or Gravity Operated as shown on the Contract Drawings.

2. Bird Screen: ½-in. (13 mm) mesh Type 316 stainless steel screen securely anchored to housing at air outlet. Provide type 316 insect screen where shown on the Contract Drawings.

3. Curb Gasket: Self-adhesive gasket of Buna-N, EPDM, or Hypalon cemented to inner edge of curb to provide air and water seal between curb and housing.

4. Base to Curb Fasteners: Type 316 stainless steel lag screws and bolts.

5. Prefabricated Roof Curb:

a. Weatherproof, continuous welded minimum 14 ga. aluminum construction.

b. Insulated with 2-in. minimum fiberglass sandwiched between inner and outer walls of curb.

c. 45° canted type sides.

d. Provide curb with gasket as per above and wood blocking to mount curb. Provide flashing and counter flashing at curb as required to make watertight installation.

e. 12-in. minimum curb height measured from finished roof to top of pressure treated wood nailer.

f. Curb to Roof Deck Fasteners: Type 316 stainless steel lag screws and bolts.

g. Refer to architectural Contract Drawings for curb flashing details.

h. Contractor shall furnish prefabricated roof curbs from the same manufacturer as the air intakes and relief vents.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting:

1. All exterior and interior surfaces of equipment, including all accessories, shall be coated with a dry phenolic coating system.

a. Finish and color to match housing.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspection:

1. The Contractor shall not install damaged items until repairs are made in accordance with manufacturer's written instructions and approval by Engineer.
    a. Only minor repair work will be permitted in the field.
    b. All damaged items requiring remedial work shall be returned to the manufacturer for repair or replacement

B. Examine curbs to receive air intake and relief vents for:
1. Horizontal mounting surface.
2. Water tightness.
3. Proper anchoring and flashing of prefabricated curb to roof deck.
4. Unevenness, irregularities, and incorrect dimensions that would affect quality and execution of installation.

C. Do not proceed with installation of air intake and relief vents until curbs conform to Contract requirements.

3.02 INSTALLATION

A. Roof openings and penetrations shall be capped to prevent weather from entering building prior to installation of air intakes or relief vents.

B. Install air outlets and inlets in complete accordance with manufacturer's printed installation instructions and the approved shop drawings.

C. Anchor base to wood nailer on curb with lag screws or bolts in manner that allows for easy removal for damper service.

D. Check proper connections for electrical wiring hook-ups for motorized dampers.

3.03 FIELD TESTING / QUALITY CONTROL

A. Furnish the services of a qualified manufacturer's representative to check and approve all installations before operation, in accordance with the requirements of the Contract Documents. In addition:
1. The Contractor shall verify that all Work furnished and installed conforms to the requirements the Contract Documents.
2. Verify that the unit is secured to supports, and that duct connections are complete.
3. Verify that cleaning is complete.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjusting:

1. Upon completion of the installation, the Contractor shall adjust all air intake and relief vents for their intended use.

B. Protection:

1. The air outlets and inlets shall be protected as per the requirements of the Contract Documents. The use of the air outlets and inlets shall not be permitted until permission is given by the Engineer.

C. Cleaning:

1. In addition to the requirements of the Contract Documents, the Contractor shall thoroughly remove all debris and waste materials resulting from installation.
2. Clean tar, dirt, and marks from exterior of units.
3. Touch up all chips in factory finishes.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 05 48.13 – Vibration Controls for HVAC

B. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

C. Section 23 31 14 – Metal Ducts and Accessories

D. Section 26 05 20 – Low-Voltage Wires, Cables, and Accessories

E. Section 26 05 27 – Grounding

F. Section 26 05 53 – Identification for Electrical Systems

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. Section includes packaged, rooftop air conditioning units (RTUs) with the following components:

1. Unit Casings.
2. Fans, drives, and motors.
3. Coils.
4. Refrigerant circuit components.
5. Air filtration.
6. Electrical power connections.
7. Controls.
8. Accessories.
9. Materials.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each RTU.
    a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
    b. Include rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
    c. Include unit dimensions and weight.
    d. Include cabinet material, metal thickness, finishes, insulation, and accessories.
    e. Fans:
        1) Include certified fan-performance curves with system operating conditions indicated.
        2) Include certified fan-sound power ratings.
        3) Include fan construction and accessories.
        4) Include motor ratings, electrical characteristics, and motor accessories.

f. Include certified coil-performance ratings with system operating conditions indicated.

g. Include filters with performance characteristics.

h. Include gas furnaces with performance characteristics.

i. Include factory selection calculations for each antimicrobial ultraviolet lamp installation.

j. Include dampers, including housings, linkages, and operators.

2. Shop Drawings: For each packaged, rooftop air-conditioning units.

a. Include plans, elevations, sections, and mounting details.

b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

c. Include diagrams for power, signal, and control wiring.

3. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.

a. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

b. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

c. Wind-Restraint Details: Detail fabrication and attachment of wind restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

B. Informational Submittals

1. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

2. Sample Warranty: For manufacturer's warranty.

3. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 23 05 48.13 "Vibration Controls for HVAC."

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

b. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Source quality-control reports.

5. System startup reports.

6. Field quality-control reports.

C. Closeout Submittals

1. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

D. Maintenance Material Submittals

1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Filters: One set of filters for each unit.

b. Gaskets: One set for each access door.

c. Fan Belts: One set for each belt-driven fan.

d. Filters: One set of filters for each unit.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Model CyberPack as manufactured by Stulz Air Technology Systems Inc., Frederick, MD

B. Model WHC as manufactured by Trane, La Crosse, WI

C. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Performance Requirements

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
3. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
4. ASHRAE 15 Compliance: For refrigeration system safety.
5. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
    a. Delegated Design: Engage a qualified Professional Engineer, as defined in Section 01 40 00 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
        1) Design RTU supports to comply with wind performance requirements.

B. Unit Casings

a. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

b. Double-Wall Construction:

1) Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

2) Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick, perforated 40 percent free area.

3) Floor Plate: G90 galvanized steel, treadplate, minimum 18 gauge.

4) Casing Insulation:

a) Materials: Injected polyurethane foam insulation.

b) Casing Panel R-Value: Minimum <Insert value>.

c) Insulation Thickness: 1 inch.

d) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

c. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

d. Static-Pressure Classifications:

1) For Unit Sections Upstream of Fans: Minus 3-inch wg.

2) For Unit Sections Downstream and Including Fans: 4-inch wg.

e. Panels and Doors:

1) Panels:

a) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.

b) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.

c) Gasket: Neoprene, applied around entire perimeters of panel frames.

d) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

2) Access Doors:

a) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.

b) Gasket: Neoprene, applied around entire perimeters of panel frames.

c) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

3) Locations and Applications:

a) Fan Section: Inspection and access panels.

b) Access Section: Doors.

c) Coil Section: Inspection and access panels.

d) Damper Section: Inspection and access panels.

e) Filter Section: Doors large enough to allow periodic removal and installation of filters.

f) Mixing Section: Doors.

f. Condensate Drain Pans:

1) Location: Each type of cooling coil.

2) Construction:

a) Double-wall, galvanized-steel or noncorrosive polymer sheet with space between walls filled with foam insulation and moisture-tight seal.

3) Drain Connection:

a) Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

b) Minimum Connection Size: NPS 1.

4) Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

5) Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.

6) Width: Entire width of water producing device.

7) Depth: A minimum of 2 inches deep.

8) Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.

9) Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

C. Fans, Drives, and Motors

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

2. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway.

b. Shaft Bearings:

1) Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.

c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

d. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.

e. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

f. Shaft Lubrication Lines: Extended to a location outside the casing.

g. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch- thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

3. Drives, Direct: Factory-mounted, direct drive.

4. Drives, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.

c. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- thick, diamond-mesh wire screen, welded to steel angle frame; prime coated.

5. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated ECM motors.

6. Motors:

a. Motor Sizes: Minimum size as indicated in Contract Drawings. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

1) Enclosure Type: Open, dripproof.

2) Enclosure Materials: Cast iron.

3) Motor Bearings: Sealed ball or roller bearings.

4) Efficiency: Premium efficient as defined in NEMA MG 1.

5) NEMA Design: Design B.

b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

D. Coils

1. General Requirements for Coils:

a. Comply with AHRI 410.

b. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).

c. Coils shall not act as structural component of unit.

2. Supply-Air Refrigerant Coil:

a. Tubes: Copper.

b. Fins:

1) Material: Aluminum.

2) Fin Spacing: Maximum 12 fins per inch.

c. Fin and Tube Joints: Mechanical bond.

d. Headers: Seamless-copper headers with brazed connections.

e. Frames: Galvanized steel.

f. Coatings: Corrosion-resistant coating.

g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

1) Working Pressure: Minimum 300 psig.

3. Electric-Resistance Heating Coils: Comply with UL 1995.

a. Casing Assembly: Slip-in type with galvanized-steel frame.

b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.

d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

e. Control Panel: Unit mounted with disconnecting means and overcurrent protection.

1) Magnetic contactor.

2) Solid-state, stepless pulse controller.

3) Toggle switches, one per step.

4) Step controller.

5) Time-delay relay.

6) Pilot lights, one per step.

7) Airflow proving switch.

E. Refrigerant Circuit Components

1. Compressor: Hermetic, variable speed scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.

2. Refrigeration Specialties:

a. Refrigerant: R-410A.

b. Expansion valve with replaceable thermostatic element.

c. Refrigerant filter/dryer.

d. Manual-reset high-pressure safety switch.

e. Automatic-reset low-pressure safety switch.

f. Minimum off-time relay.

g. Automatic-reset compressor motor thermal overload.

h. Brass service valves installed in compressor suction and liquid lines.

i. Low-ambient kit high-pressure sensor.

j. Hot-gas reheat solenoid valve single stage with a replaceable magnetic coil.

k. Hot-gas bypass solenoid valve with a replaceable magnetic coil.

l. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

F. Air Filtration

1. Panel Filters:

a. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.

b. Filter Unit Class: UL 900.

c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.

d. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

2. Bag Filter:

a. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames in steel, basket-type retainers.

b. Filter Unit Class: UL 900.

c. Media: Fibrous material, with antimicrobial coating, constructed so individual pockets are maintained in tapered form by flexible internal supports under rated-airflow conditions.

d. Filter-Media Frame: Galvanized steel.

3. Cartridge Filters:

a. Description: Factory-fabricated, adhesive-coated disposable, packaged air filters with media perpendicular to airflow, and with holding frames.

b. Filter Unit Class: UL 900.

c. Media: Fibrous material, with antimicrobial coating, constructed so individual pleats are maintained in pleated form under rater-airflow conditions by corrugated aluminum separators.

d. Filter Media Frame: Galvanized steel.

G. Electrical Power Connections

1. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

H. Controls

1. Controller:

a. Controller shall have volatile-memory backup.

b. Controller shall have LCD user interface with the following functionality:

1) Adjusting set points.

2) Monitoring supply fan start, stop, and operation.

3) Inquiring data to include supply- and room-air temperature.

4) Monitoring occupied and unoccupied operations.

5) Monitoring constant and variable motor loads.

6) Monitoring variable-frequency drive operation.

7) Monitoring cooling load.

8) Monitoring air-distribution static pressure and ventilation air volume.

c. Normal Operation:

1) A temperature sensor furnished by RTU manufacturer and field installed by installing HVAC Contractor shall be space mounted and shall transmit a proportional control signal to a corresponding controller to automatically maintain space temperature.

d. Safety Control Operation:

1) Smoke Detectors: Stop fan if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.

2) Firestats: Stop fan if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.

3) Fire Alarm Control Panel Interface: Provide control interface.

4) Low-Discharge Temperature: Stop fan if supply air temperature is less than 40 deg F.

2. Interface Requirements for HVAC Instrumentation and Control System:

a. Interface relay for scheduled/automatic or manual operation at the central HVAC control panel.

b. Interface relay to provide indication of faults and alarms at the central HVAC control panel and diagnostic code storage.

I. Accessories

1. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

3. Safeties:

a. Smoke detector.

b. Condensate overflow switch.

c. Phase-loss reversal protection.

d. High and low pressure control.

e. Electric coil airflow-proving switch.

4. Coil guards of painted, galvanized-steel wire.

5. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

6. Outdoor air intake weather hood with moisture eliminator.

7. Service Lights and Switch: Factory installed in each accessible section with weatherproof cover. Factory wire lights to a single-point field connection.

J. Materials

1. Steel:

a. ASTM A36/A36M for carbon structural steel.

b. ASTM A568/A568M for steel sheet.

2. Stainless Steel:

a. Manufacturer's standard grade for casing.

b. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

3. Galvanized Steel: ASTM A653/A653M.

4. Aluminum: ASTM B209

5. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [3000] <Insert time>-hour salt-spray test according to ASTM B117.

a. Standards:

1) ASTM B117 for salt spray.

2) ASTM D2794 for minimum impact resistance of 100 in-lb.

3) ASTM B3359 for cross-hatch adhesion of 5B.

b. Application: Immersion.

c. Thickness: 1 mil.

d. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. AHRI Compliance:

1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested in accordance with AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Unit Support: Install unit level on structural steel supports. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

C. Piping Connections

1. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Where installing piping adjacent to RTU, allow space for service and maintenance.
3. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

D. Duct Connections

1. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
2. Connect supply and return ducts to RTUs with flexible duct connectors specified in Section 23 31 14 "Metal Ducts and Accessories."

E. Electrical Connections

1. Connect electrical wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
2. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
3. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
4. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
5. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 26 05 53 "Identification for Electrical Systems."
6. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch high.
7. Locate nameplate where easily visible.

F. Control Connections

1. Install control and electrical power wiring to field-mounted control devices.
2. Connect control wiring according to Section 26 05 20 " Low-Voltage Wires, Cables, and Accessories"

3.03 FIELD TESTING / QUALITY CONTROL

A. Testing

1. All tests shall be performed in accordance with the requirements of the Contract Documents.
2. Field tests shall be performed in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

B. Manufacturer’s Representative

1. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract. The services of the manufacturer's representative shall be provided for a period indicated and as specified in the Contract Documents.
2. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's

representative shall sign in and out at the office of the Resident Engineer each day they are at the Project.

3. Training:

a. The Contractor shall provide training for personnel. The Contractor shall include in his request for manufacturer approval a certification that the manufacturer has been advised of the stringent requirements for training, and that the costs associated with said training submittals and training have been included in the manufacturer's pricing.

3.04 STARTUP / DEMONSTRATION

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Inspect for visible damage to unit casing.

D. Inspect for visible damage to compressor, coils, and fans.

E. Inspect internal insulation.

F. Verify that labels are clearly visible.

G. Verify that clearances have been provided for servicing.

H. Verify that controls are connected and operable.

I. Verify that filters are installed.

J. Clean condenser coil and inspect for construction debris.

K. Remove packing from vibration isolators.

L. Verify lubrication on fan and motor bearings.

M. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

N. Adjust fan belts to proper alignment and tension.

O. Start unit according to manufacturer's written instructions.

P. Start refrigeration system.

Q. Do not operate below recommended low-ambient temperature.

R. Complete startup sheets and attach copy with Contractor's startup report.

S. Inspect and record performance of interlocks and protective devices; verify sequences.

T. Operate unit for an initial period as recommended or required by manufacturer.

U. Calibrate thermostats.

V. Adjust and inspect high-temperature limits.

W. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

X. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:

1. Coil leaving-air, dry- and wet-bulb temperatures.
2. Coil entering-air, dry- and wet-bulb temperatures.
3. Outdoor-air, dry-bulb temperature.
4. Outdoor-air-coil, discharge-air, dry-bulb temperature.

Y. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

Z. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

1. Supply-air volume.
2. Return-air volume.
3. Relief-air volume.
4. Outdoor-air intake volume.

AA. Simulate maximum cooling demand and inspect the following:

1. Compressor refrigerant suction and hot-gas pressures.
2. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

BB. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems and after completing startup service, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete

B. Section 07 72 46 - Roof Walkways

C. Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment

D. Section 23 05 53 – Identification for HVAC Piping and Equipment

E. Section 23 07 19 – HVAC Piping Insulation

F. Section 23 09 00 - Instrumentation and Controls Scope and General Requirements

G. Section 23 09 13 - Instrumentation and Control Devices for HVAC

H. Section 23 09 14 - Control Panels, Enclosures and Devices for HVAC.

I. Section 23 21 13 – Hydronic Piping

J. Section 23 21 16 – Refrigerant Piping

K. Section 23 31 14 – Metal Ducts and Accessories

L. Section 26 05 20 – Low-Voltage Wires, Cables and Accessories

M. Section 26 05 27 – Grounding

N. Section 26 05 33 – Raceways and Boxes for Electrical Systems

1.04 REFERENCES

A. Air-Conditioning and Refrigeration Institute (ARI): ARI 1230 - Performance Rating of Variable Refrigerant Flow Multi-Split Air-Conditioning and Heat Pump Equipment

B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

1. ASHRAE 15 - Safety Standard for Refrigeration Systems

2. ASHRAE 51 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

3. ASHRAE 52 - Method of Testing General Ventilation Air-Cleaning Devices for Removal efficiency by Particle Size

C. American National Standards Institute (ANSI) / Air Movement and Control Association International, Inc. (AMCA):

1. ANSI/AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

2. ANSI/AMCA 300 - Reverberant Room Method for Sound Testing of Fans

3. ANSI/AMCA 500 - Laboratory Methods of Testing Dampers for Rating

D. ASTM International (ASTM):

1. ASTM B117 - Salt Spray Testing Standards

E. National Electrical Manufacturers Association (NEMA):

1. NEMA ICS 1 General Standards for Industrial Control and Systems

F. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code (NEC)

G. Underwriters' Laboratories, Inc., (UL):

1. UL 1025 - Electric Air Heaters
2. UL 1995 - Heating and Cooling Equipment

1.05 A. DESCRIPTION

A. Section includes complete variable refrigerant flow (VRF) HVAC system(s) including, but not limited to delegated design and the following components to make a complete operating system(s) according to requirements indicated:

1. Indoor, exposed, wall-mounted units.
2. Indoor, recessed, ceiling-mounted units.
3. Outdoor, air-source, heat-pump units.
4. System controls.
5. System refrigerant and oil.
6. System condensate drain piping.
7. System refrigerant piping.
8. Metal hangers and supports.
9. Piping and tubing insulation.
10. System control cable and raceways.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of **five** years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least **five** completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
   a. Product research and development.
   b. Product and application engineering.

c. Product manufacturing, testing, and quality control.

d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.

e. Owner training.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.

2. In-place facility located within 50 miles of Project.

3. Demonstrated past experience with products being installed for period within **five** consecutive years before time of bid.

4. Demonstrated past experience on **five** projects of similar complexity, scope, and value.

a. Each person assigned to Project shall have demonstrated past experience.

5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.

6. Service and maintenance staff assigned to support Project during warranty period.

7. Product parts inventory to support ongoing system operation for a period of not less than **five** years after Substantial Completion.

8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

2. Installer certification shall be valid and current for duration of Project.

3. Retain copies of Installer certificates on-site and make available on request.

4. Each person assigned to Project shall have demonstrated past experience.

a. Demonstrated past experience with products being installed for period within **five** consecutive years before time of bid.

b. Demonstrated past experience on **five** projects of similar complexity, scope, and value.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units.

b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

c. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.

d. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.

e. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit control.

f. Include description of control software features.

g. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.

h. Include refrigerant type and data sheets showing compliance with requirements indicated.

i. For system design software.

j. Indicate location and type of service access.

2. Shop Drawings: For VRF HVAC systems.

a. Include plans, elevations, sections, and mounting details.

b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

c. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported

equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

d. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.

e. Include diagrams for power, signal, and control wiring.

3. Delegated-Design Submittals:

a. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

b. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.

c. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.

d. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

B. Informational Submittals

1. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

a. Suspended ceiling components.

b. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.

c. Size and location of initial access modules for acoustical tile.

d. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.

e. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.

f. Items penetrating finished ceiling including the following:

1) Luminaires.

2) Air outlets and inlets.

3) Speakers.

4) Service access panels.

2. Qualification Data:

a. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

1) Retain copies of Installer certificates on-site and make available on request.

b. For VRF HVAC system manufacturer.

c. For VRF HVAC system provider.

3. Product Certificates: For each type of product.

4. Product Test Reports: Where tests are required, for each product, test reports performed by manufacturer and witnessed by a Nationally Recognized Testing Laboratory (NRTL).

5. Source quality-control reports.

6. Field quality-control reports.

7. Sample Warranties: For manufacturer's warranties.

C. Closeout Submittals

1. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

2. Software and Firmware Operational Documentation:

a. Software operating and upgrade manuals.

b. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.

c. Device address list.

d. Printout of software application and graphic screens.

D. Maintenance Material Submittals

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Filters:

1) One set(s) for each unit with replaceable filters.

2) One set(s) for each unit type and unique size of washable filters.

b. Indoor Units: One for each unique size and type installed.

c. Controllers for Indoor Units: One for each unique controller type installed.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Indoor & Outdoor Units

1. Model Multi V Indoor & Outdoor Units as manufactured by LG Electronics USA Inc., Englewood Cliffs, NJ

2. Or approved equal

3. Source Limitations: For each building, obtain products from single source from single manufacturer including, but not limited to, the following:
   a. Indoor and outdoor units, including accessories.
   b. Controls and software.
   c. Refrigerant isolation valves.
   d. Specialty refrigerant pipe fittings.

B. Automatic Condensate Pumps
1. Model EC-1K-DV automatic condensate pumps as manufactured by Little Giant Pump Co., Oklahoma City, OK
2. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. System Description
a. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
1) Two-pipe system design.
2) System operation as indicated on Drawings.
3) Each system with one refrigerant circuit shared by all indoor units connected to system.
b. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
c. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.
d. ASHRAE Compliance:
1) ASHRAE 15: For safety code for mechanical refrigeration.
2) ASHRAE 62.1: For indoor air quality.
3) ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.
e. UL Compliance: Comply with UL 1995.

B. Performance Requirements

1. Service Access:
   a. Provide and document service access requirements.
   b. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
   c. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
   d. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
   e. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
   f. Comply with OSHA regulations.
2. System Design and Installation Requirements:
   a. Design and install systems indicated according to manufacturer's recommendations and written instructions.
   b. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.
3. Isolation of Equipment: Provide isolation valves to isolate each indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.
4. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
   a. Not less than 50 percent.
   b. Not more than 130 percent.
   c. Range acceptable to manufacturer.
5. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.
6. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

7. Outdoor Conditions:
    a. Suitable for outdoor ambient conditions encountered.
        1) Design equipment and supports to withstand wind loads of governing code and ASCE/SEI 7.
        2) Design equipment and supports to withstand snow and ice loads of governing code and ASCE/SEI 7.
        3) Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.
    b. Maximum System Operating Outdoor Temperature: 95 deg F.
    c. Minimum System Operating Outdoor Temperature: 9 deg F.
8. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
    a. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
    b. Outdoor: Within ordinance of governing authorities.
9. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.
10. Capacities and Characteristics: As indicated on Drawings.

C. Indoor, exposed, wall-mounted units
1. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
2. Cabinet:
    a. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
    b. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
    c. Mounting: Manufacturer-designed provisions for field installation.
    d. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

3. DX Coil Assembly:
    a. Coil Casing: Aluminum, galvanized, or stainless steel.
    b. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
    c. Coil Tubes: Copper, of diameter and thickness required by performance.
    d. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
    e. Unit Internal Tubing: Copper tubing with brazed joints.
    f. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
    g. Field Piping Connections: Manufacturer's standard.
    h. Factory Charge: Dehydrated air or nitrogen.
    i. Testing: Factory pressure tested and verified to be without leaks.
4. Drain Assembly:
    a. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
    b. Condensate Removal: Gravity.
        1) If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
    c. Field Piping Connection: Non-ferrous material.
5. Fan and Motor Assembly:
    a. Fan(s):
        1) Direct-drive arrangement.
        2) Single or multiple fans connected to a common motor shaft and driven by a single motor.
        3) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
        4) Wheels statically and dynamically balanced.
    b. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
    c. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

d. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

e. Vibration Control: Integral isolation to dampen vibration transmission.

6. Filter Assembly:

a. Access: Front, to accommodate filter replacement without the need for tools.

b. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

7. Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top or front face of unit cabinet.

8. Unit Accessories:

a. Condensate Pump: provide condensate pump, reservoir, level on/off sensors and overflow protection switch with electrical power connection through unit power. Provide line set cover and mounting brackets for pump.

9. Unit Controls:

a. Enclosure: Manufacturer's standard, and suitable for indoor locations.

b. Factory-Installed Controller: Configurable digital control.

c. Factory-Installed Sensors: Unit inlet air temperature, Coil entering refrigerant temperature, Coil leaving refrigerant temperature.

d. Field-Customizable I/O Capability:

1) Analog Inputs: Four for use in customizable control strategies.

2) Digital Inputs: Four for use in customizable control strategies.

3) Digital Outputs: Four for use in customizable control strategies.

e. Features and Functions: Self-diagnostics, time delay, auto-restart, external static pressure control, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, run test switch.

f. Communication: Network communication with other indoor units and outdoor unit(s).

g. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

h. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

10. Unit Electrical:

a. Enclosure: Manufacturer's standard, and suitable for indoor locations.

b. Field Connection: Single point connection to power entire unit and integral controls.

c. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

d. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

e. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

D. Indoor, recessed, ceiling-mounted units.

1. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

2. Cabinet:

a. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.

b. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

c. Mounting: Manufacturer-designed provisions for field installation.

d. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

3. DX Coil Assembly:

a. Coil Casing: Aluminum, galvanized, or stainless steel.

b. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.

c. Coil Tubes: Copper, of diameter and thickness required by performance.

d. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

e. Internal Tubing: Copper tubing with brazed joints.

f. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

g. Field Piping Connections: Manufacturer's standard.

h. Factory Charge: Dehydrated air or nitrogen.

i. Testing: Factory pressure tested and verified to be without leaks.

4. Drain Assembly:

a. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

b. Condensate Removal: Factory installed, unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.

c. Field Piping Connection: Non-ferrous material.

5. Fan and Motor Assembly:

a. Fan(s):

1) Direct-drive arrangement.

2) Single or multiple fans connected to a common motor shaft and driven by a single motor.

3) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.

4) Wheels statically and dynamically balanced.

b. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.

c. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

d. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

e. Vibration Control: Integral isolation to dampen vibration transmission.

6. Filter Assembly:

a. Access: Bottom, to accommodate filter replacement without the need for tools.

b. Efficiency: ASHRAE 52.2, MERV 7.

c. Media:

1) Washable: Manufacturer's standard filter with antimicrobial treatment.

7. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.

a. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.

1) Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.

2) Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.

b. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

c. Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one additional supply branch duct.

8. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

9. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

10. Unit Accessories:

a. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

11. Unit Controls:

a. Enclosure: Manufacturer's standard, and suitable for indoor locations.

b. Factory-Installed Controller: Configurable digital control.

c. Factory-Installed Sensors: Unit inlet air temperature, Coil entering refrigerant temperature, Coil leaving refrigerant temperature.

d. Field-Customizable I/O Capability:

1) Analog Inputs: Four for use in customizable control strategies.

2) Digital Inputs: Four for use in customizable control strategies.

3) Digital Outputs: Four for use in customizable control strategies.

e. Features and Functions: Self-diagnostics, time delay, auto-restart, external static pressure control, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, run test switch.

f. Communication: Network communication with other indoor units and outdoor unit(s).

g. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

h. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

12. Unit Electrical:

a. Enclosure: Manufacturer's standard, and suitable for indoor locations.

b. Field Connection: Single point connection to power entire unit and integral controls.

c. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

d. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

e. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

E. Outdoor, air-source, heat-pump units.

1. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
    a. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
    b. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
    c. All units installed shall be from the same product development generation.
2. Cabinet:
    a. Galvanized steel and coated with a corrosion-resistant finish.
        1) Coating with documented salt spray test performance of 1000 hours according to ASTM B117 surface scratch test (SST) procedure.
    b. Mounting: Manufacturer-designed provisions for field installation.
    c. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
3. Compressor and Motor Assembly:
    a. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
    b. Protection: Integral protection against the following:
        1) High refrigerant pressure.
        2) Low oil level.
        3) High oil temperature.
        4) Thermal and overload.
        5) Voltage fluctuations.
        6) Phase failure and phase reversal.
        7) Short cycling.

c. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.

d. Vibration Control: Integral isolation to dampen vibration transmission.

e. Oil management system to ensure safe and proper lubrication over entire operating range.

f. Crankcase heaters with integral control to maintain safe operating temperature.

g. Fusible plug.

4. Condenser Coil Assembly:

a. Plate Fin Coils:

1) Casing: Aluminum, galvanized, or stainless steel.

2) Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.

3) Tubes: Copper, of diameter and thickness required by performance.

b. Aluminum Microchannel Coils:

1) Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.

2) Single- or multiple-pass arrangement.

3) Construct fins, tubes, and header manifolds of aluminum alloy.

c. Coating: Corrosion resistant.

5. Condenser Fan and Motor Assembly:

a. Fan(s): Propeller type.

1) Direct-drive arrangement.

2) Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.

3) Statically and dynamically balanced.

6. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
7. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
8. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
9. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
10. Vibration Control: Integral isolation to dampen vibration transmission.
11. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
12. Unit Controls:
    a. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
    b. Factory-Installed Controller: Configurable digital control.
    c. Factory-Installed Sensors:
        1) Refrigerant suction temperature.
        2) Refrigerant discharge temperature.
        3) Outdoor air temperature.
        4) Refrigerant high pressure.
        5) Refrigerant low pressure.
        6) Oil level.
    d. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch, equalize run time between multiple same components.
    e. Communication: Network communication with indoor units and other outdoor unit(s).
    f. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
    g. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
13. Unit Electrical:

a. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.

b. Field Connection: Single point connection to power entire unit and integral controls.

c. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

d. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

e. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

14. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

15. Unit Piping:

a. Unit Tubing: Copper tubing with brazed joints.

b. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

c. Field Piping Connections: Manufacturer's standard.

d. Factory Charge: Dehydrated air or nitrogen.

e. Testing: Factory pressure tested and verified to be without leaks.

F. System controls.

1. General Requirements:

a. Network: Indoor units and outdoor units shall include integral controls and connect through a TIA-485A or manufacturer-selected control network.

b. Network Communication Protocol: Manufacturer proprietary or open control communication between interconnected units.

c. Operator Interface:

1) Operators shall interface with system and unit controls through the following:

a) Operator interfaces integral to controllers.

b) Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

(1) On/off control.

(2) Temperature set-point adjustment.

2. Wired Controllers for Indoor Units:

a. Single controller capable of controlling multiple indoor units as group.

b. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.

c. Temperature Units: Fahrenheit.

d. On/Off: Turns indoor unit on or off.

e. Hold: Hold operation settings until hold is released.

f. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.

g. Temperature Display: 1-degree increments.

h. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments.

i. Relative Humidity Display: 1 percent increments.

j. Relative Humidity Set-Point: Adjustable in 1 percent increments.

k. Fan Speed Setting: Select between available options furnished with the unit.

l. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.

m. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.

n. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.

o. Occupancy detection.

p. Service Notification Display: "Filter".

q. Service Run Tests: Limit use by service personnel to troubleshoot operation.

r. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.

s. User and Service Passwords: Capable of preventing adjustments by unauthorized users.

t. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.

u. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

G. System refrigerant and oil.

1. Refrigerant:

a. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.

b. ASHRAE 34, Class A1 refrigerant classification.

c. R-410a.

2. Oil:

a. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

H. System condensate drain piping.

1. Refer to Section 23 21 13 – Hydronic Piping for condensate drain piping specifications.

I. Automatic condensate pumps.

1. Source Limitations: Obtain pump units from single source from single manufacturer.

2. Description: Packaged units with corrosion-resistant pump, reservoir with cover, and automatic controls including level on/off sensor and overflow protection switch. Collects and removes condensate from indoor units and similar components. Include factory- or field-installed check valve and 72-inch- minimum, electrical power cord with plug. Electrical power connection through unit power. Provide line set cover and mounting brackets for pump.

J. System refrigerant piping.

1. Refer to Section 23 21 16 – Refrigerant Piping for refrigerant piping specifications.

K. Metal hangers and supports.

1. Refer to Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment for metal hanger and supports specifications.

L. Piping and tubing insulation.

1. Refer to Section 23 07 19 – HVAC Piping Insulation for piping and tubing insulation specifications.

M. System control cable and raceways.

1. Cable Rating: Listed and labeled for application according to NFPA 70.

a. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1) Flame Travel Distance: 60 inches or less.

2) Peak Optical Smoke Density: 0.5 or less.

3) Average Optical Smoke Density: 0.15 or less.

b. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

c. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2. Low-Voltage Control Cabling:

a. Paired Cable: NFPA 70, Type CMG.

1) One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.

2) PVC insulation.

3) Braided or foil shielded.

4) PVC jacket.

5) Flame Resistance: Comply with UL 1685.

b. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1) One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.

2) PVC insulation.

3) Braided or foil shielded.

4) PVC jacket.

5) NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

6) Flame Resistance: Comply with NFPA 262.

3. TIA-485A Network Cabling:

a. Standard Cable: NFPA 70, Type CMG.

1) Paired, one pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.

2) PVC insulation.

3) Unshielded.

4) PVC jacket.

5) Flame Resistance: Comply with UL 1685.

b. Plenum-Rated Cable: NFPA 70, Type CMP.

1) Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.

2) Fluorinated ethylene propylene insulation.

3) Unshielded.

4) Fluorinated ethylene propylene jacket.

5) NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

6) Flame Resistance: NFPA 262.

4. Comply with requirements in Section 26 05 33 – Raceways and Boxes for Electrical Systems for control wiring and cable raceways.

N. Materials

1. Steel:

a. ASTM A36/A36M for carbon structural steel.

b. ASTM A568/A568M for steel sheet.

2. Stainless Steel:

a. Manufacturer's standard grade for casing.

b. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

3. Galvanized Steel: ASTM A653/A653M.

4. Aluminum: ASTM B209.

5. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

a. Standards:

1) ASTM B117 for salt spray.

2) ASTM D2794 for minimum impact resistance of 100 in-lb.

3) ASTM B3359 for cross-hatch adhesion of 5B.

b. Application: Immersion.

c. Thickness: 1 mil.

d. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Submit shop test and inspection reports.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Equipment Installation, General

1. Clearance:

a. Maintain manufacturer's recommended clearances for service and maintenance.

b. Maintain clearances required by governing code.

2. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

a. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.

B. Installation of Indoor Units

1. Install units to be level and plumb while providing a neat and finished appearance.

2. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.

3. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

4. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

5. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

6. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

7. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.

8. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

9. Floor-mounted units located in mechanical rooms.

C. Installation of Outdoor Units

1. Install units to be level and plumb while providing a neat and finished appearance.

2. Install outdoor units on support structures indicated on Drawings.

3. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 - Cast-in-Place Concrete.

   a. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.

   b. Grouting: Place grout under equipment supports and make bearing surface smooth.

4. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section 07 72 00 - Roof Walkways. Anchor units to supports with removable, stainless-steel fasteners.

D. Installation of System Condensate Drain Piping

1. Comply with requirements for condensate drain piping specified in Section 23 21 13 – Hydronic Piping.

E. Installation of Automatic Condensate Pump

1. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

2. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3. Install overflow protection switch per manufacturer's wiring recommendations.

4. For wall mounted indoor units, mount reservoir and condensate pump inside line set cover.

F. Installation of Refrigerant Piping

1. Comply with requirements for refrigerant piping specified in Section 23 21 16 – Refrigerant Piping.

G. Installation of Metal Hangers and Supports

1. Comply with requirements for metal hangers and supports specified in Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment.

H. Installation of Piping and Tubing Insulation

1. Comply with requirements for piping and tubing insulation specified in Section 23 07 19 – HVAC Piping Insulation.

I. Installation of Ducts and Accessories

1. Comply with requirements for metal ducts and accessories specified in Section 23 31 14 – Metal Ducts and Accessories.

J. Electrical Installation

1. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

a. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

2. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

3. Comply with requirements in Section 26 05 20 – Low-Voltage Wires, Cables and Accessories for wiring connections.

4. Comply with requirements in Section 26 05 27 – Grounding for grounding connections.

5. Comply with requirements in Section 26 05 33 – Raceways and Boxes for Electrical Systems for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.

K. Installation of System Control Cable

1. Comply with requirements for system control cable specified in Section 23 09 00 - Instrumentation and Controls Scope and General Requirements, Section 23 09 13 - Instrumentation and Control Devices for HVAC, and Section 23 09 14 - Control Panels, Enclosures and Devices for HVAC.

L. Grounding Installation

1. For low-voltage control cabling, comply with requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

M. Identification

1. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 23 05 53 – Identification for HVAC Piping and Equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.04 STARTUP / DEMONSTRATION

A. Startup

1. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.
   a. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
   b. Complete startup service of each separate system.
   c. Complete system startup service according to manufacturer's written instructions.
2. Startup checks shall include, but not be limited to, the following:
   a. Check control communications of equipment and each operating component in system(s).
   b. Check each indoor unit's response to demand for cooling and heating.
   c. Check each indoor unit's response to changes in airflow settings.
   d. Check each indoor unit and outdoor unit for proper condensate removal.
   e. Check sound levels of each indoor and outdoor unit.
3. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
   a. Installer shall correct deficiencies found during startup service for reverification.

4. System Operation Report:
   a. After completion of startup service, manufacturer shall issue a report for each separate system.
   b. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
   c. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
      1) All available system operating parameters shall be included in the information submitted.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjusting
   1. Adjust equipment and components to function smoothly and lubricate as recommended by manufacturer.
   2. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
   3. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

B. Protection
   1. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
   2. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
   3. Protect equipment from electrical damage. Replace equipment suffering electrical damage.
   4. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 09 13 – Instrumentation and Control Devices for HVAC

B. Section 26 05 27 – Grounding

C. Section 26 05 20 – Low-Voltage Wires, Cables and Accessories.

1.04 REFERENCES

A. Reference Standard:

1. ASHRAE The American Society of Heating, Refrigerating and Air-Conditioning Engineers
    a. Standard 62.1 - The Standards for Ventilation and Indoor Air Quality
2. NFPA National Fire Protection Agency
    a. 1. NFPA 70 - National Electrical Code
3. UL Underwriters Laboratory
    a. UL 1996 – Electric Duct Heaters
4. SMACNA Sheet Metal and Air Conditioning Contractors National Association
    a. HVAC Duct Construction Standards.

B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
1. HVAC Duct Construction Standards.

1.05 DESCRIPTION

A. Section includes the following electric-resistance air coils:
1. Electric baseboard heaters
2. Electric duct heaters

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Action Submittals
1. Product Data: For each type of product.
    a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
    b. Include rated capacities, operating characteristics, and pressure drops for each air coil.
2. Shop Drawings: Include diagrams for power, signal, and control wiring.

B. Informational Submittals
1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

C. Closeout Submittals

1. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Electric baseboard heaters:

1. Indeeco, St. Louis, MO
2. Chromalox, Inc., Pittsburgh, PA
3. Brasch Manufacturing Co., Inc., Maryland Heights, MO
4. Or approved other.

B. Electric duct heaters:

1. Renewaire, Waunakee, WI
2. Indeeco, St. Louis, MO
3. Chromalox, Inc., Pittsburgh, PA
4. Or approved other.

2.02 MATERIALS / EQUIPMENT

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. Electric baseboard heaters

1. Coils

a. Testing Agency Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency recognized under 29 CFR 1910.7 and marked for intended location and application.

b. Coil Assembly: Comply with UL 1995.

c. Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.

2. Housing

   a. Cabinet shall be constructed of 20-gauge galvanized steel with a robust aluminum front cover. The unit shall have a epoxy/polyester powder paint with satin finish in white or metallic charcoal.

3. Inlet/outlet grilles

   a. The fresh air inlet grille shall be located at the bottom of the front of the unit. The outlet shall be located at the top with openings less than 0.25-inches to discourage tampering with the heating element (pencil-proof).

4. Built-in controls

   a. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.

      1) Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

   b. Adjustable thermostat, double pole, 277V Max, 25 Amp with off position

5. Electrical connection

   a. Each baseboard heater shall have a junction box located on both ends and a built-in full length wire way

   b. Factory built-in disconnect switch, 277V Max, double-pole, 16 Amp

C. Electric duct heaters

1. Type: Heaters shall be of the slip-in mount type for duct mounting.

2. Heating Elements:

   a. Open coil of resistance wire, 60 percent nickel, 20 percent chromium, and 20 percent iron supported and insulated by floating ceramic bushings. Heating element support structure shall consist of galvanized steel wire formed and constructed to support ceramic bushings through which the heating element passes.

   b. All heating elements shall be made of nickel/chromium resistance wire with ends terminated by means of staking and heliarc welding to machine screws.

   c. Coil Layout: Vertical (air flow horizontal)

3. Casing Assembly: Slip-in type, galvanized-steel frame

4. Coil terminals shall be nickel plated, terminal insulators and bracket bushings shall be of ceramic and securely positioned.

5. Control Box: Control cabinet shall have a solid cover also of heavy gauge galvanized steel and held in place with hinges and interlocking disconnect switch.

6. Orientation: Heaters shall be interchangeable for mounting in a horizontal or vertical duct.

    a. Heaters up to 60 kW shall be capable of being rotated 180 degrees.

7. Built-in components shall include disconnecting break magnetic contactors, transformer with primary fusing, pressure-type airflow switch set at 0.05 + 0.02 in. w.g. all as required by UL, branch circuit fuses per NEC, interlocking disconnect switch and a single terminal block to accept the number, type and size of conductors as required.

8. Over-Temperature Protection:

    a. Serviceable through electric duct heater without removing heater from duct or unit.

    b. Disk-type, automatic reset, thermal-cutout safety devices for primary over-temperature protection.

    c. Secondary over-temperature protection by built in disc type manually resettable thermal cutouts.

    d. The primary and secondary devices shall function independently of one another and are not acceptable if series connected in the control circuit wiring.

    e. All duct heaters will require either a fan interlock circuit or an airflow switch. The airflow switch shall be diaphragm operated differential pressure switch to prevent duct heater from operating when there is no air flow.

9. A disconnecting magnetic control circuit is required.

10. All wiring, component sizing, component spacing and protective devices within the control cabinet shall be factory installed and comply with NEC and UL standards.

11. Control Panel: Mounted on unit, with means of a safety disconnect and overcurrent protection. Include the following controls:

    a. Magnetic contactor.

    b. Single-stage Silicon Controlled Rectifier (SCR) that shall be capable of accepting 0-10Vdc or 4-20mA as control signal

    c. 24V control voltage

12. A wiring diagram depicting layout and connections of electrical components within the control cabinet shall be affixed to the inside of the control cabinet cover.

13. A rating plate label shall be affixed to the exterior of the control cabinet cover which states model number, serial number, volts, amps, phase, frequency, control volts, volt-amps and minimum airflow requirements.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examination

1. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Electric baseboard heater

1. All installation shall be in accordance with manufacturer's published recommendations.
2. Inspect areas and conditions under which heater units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
3. Do not install heaters beneath a wall outlet.
4. Do not install heater against combustible low-density cellulose fiberboard surfaces.
5. Install coils level and plumb.
6. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

B. Electric duct heater

1. Locate, orient, and connect ductwork per AMCA, ASHRAE, and SMACNA guidelines. Provide service clearances as indicated on the plans. Locate units distant from sound critical occupancies.
2. Provide a structurally suitable support as necessary for all units. Installation shall meet or exceed all applicable federal, state and local requirements,

referenced standards and conform to codes and ordinances of authorities having jurisdiction.

3. Perform all Work required to install the electric duct heaters, with supplementary items necessary for proper installation.

4. All installation shall be in accordance with manufacturer's published recommendations.

5. Inspect areas and conditions under which heater units are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to installer.

6. Do not operate electric heaters for any purpose until ductwork is clean of any possible debris.

7. Maintain minimum working clearances around the heater electrical panel in accordance with NEC Article 110.

8. Install duct heaters in metal ducts and casings constructed according to SMACNA "HVAC Duct Construction Standards."

9. If applicable, anchor duct heaters in position using suitable supports.

10. Connect duct heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.

C. Connections

1. Ground equipment according to Section 26 05 26 – Grounding and Bonding for Electrical Systems.

2. Connect wiring according to Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

3.03 FIELD TESTING / QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. After installation is completed, including painting, clean unit's exposed surfaces and vacuum clean electric duct heaters and inside of cabinets.

B. Touch up scratches and marks from handling and placement of equipment with masking enamel to match manufacturer's color. Refer to Section 09 91 00 - Painting for site-applied finishes.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified, and required to furnish, install and test all unit heaters, complete and operational.

B. The following index of this Section is presented for convenience:

C. All unit heaters shall be provided in accordance with the schedule shown on the Contract Drawings.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

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

C. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

D. Section 26 05 91 – Low-Voltage Electric Motors

E. Section 40 05 97 – Identification for Process Equipment

1.04 REFERENCES

A. Reference Standards

1. ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality
2. NFPA 70 – National Electrical Code (NEC)
3. UL 2021 – Fixed and Location-Dedicated Electric Room Heaters

1.05 DESCRIPTION

A. This Section includes requirements for providing unit heaters and accessories in accordance with applicable standards and regulations. In addition:

1. Unit heaters shall be furnished complete with all accessories, special tools, spare parts, attachments, mountings, anchor bolts, and other appurtenances as specified and/or as may be required for a proper installation.

1.06 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of the standards organizations and regulatory agencies, below.

1. American Society of Mechanical Engineers.
2. American Society of Testing Materials.
3. Air Movement and Control Association.
4. Air Conditioning and Refrigeration Institute.
5. National Electrical Code.
6. Standards of the Hydraulic Institute
7. American National Standard Institute.
8. National Fire Protection Association.
9. Applicable Federal, State, and local laws and/or ordinances

B. Qualifications of Manufacturer:

1. All components of the unit heaters shall be provided by the Contractor through a single vendor.

a. The Contractor (through the unit heater vendor) shall have the sole responsibility of matching all components and providing equipment which functions together as a system.

2. The unit heaters shall be standard equipment of the manufacturer.

3. The unit heaters shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

4. Provide units listed by the Underwriters Laboratories, Inc.

C. Regulatory Requirements:

1. The Work of this Section shall be performed by a plumber licensed by the local authority having jurisdiction.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

a. Equipment specifications and data sheets identifying all materials used and methods of fabrication.

b. Complete assembly, layout, and installation drawings with clearly marked dimensions.

c. Fan performance data.

d. Coil performance data.

e. Details of corrosion resistance coating.

f. Weights of assembled units.

g. Motor nameplate data as specified in Section 26 05 91, Low-Voltage Electric Motors.

h. Example equipment nameplate data sheet.

i. Schematic diagrams for electric and control systems showing wiring for individual equipment items and interconnecting wiring diagrams.

j. Shop and field testing procedures.

k. List of recommended lubricants.

l. Operation and Maintenance Manuals.

2. Information Submittals:

a. Spare Parts List.

b. Special Tools List

c. Reports of Certified Shop Tests.

d. List of Lubricants:

1) The manufacturer shall submit a list with a minimum of four (4) manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required.

a) The Contractor shall utilize this list in preparing his comprehensive lubrication survey as described in the Contract Documents.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The cleaning, preservation and packing of the unit heaters for shipment shall be in accordance with the manufacturer's commercial practice.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The unit heaters shall be handled in such a manner that they may be transported and unloaded without being over-stressed, deformed, or otherwise damaged.

2. The unit heaters shall be protected from corrosion and deterioration and shall be stored in a dry area.

a. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with effective and durable waterproof covers approved by the Engineer.

3. Interiors shall be kept free from dirt and foreign matter.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools necessary to service, disassemble, repair and adjust the equipment provided under this Section, and as per the requirements of the Contract Documents and/or as recommended by the manufacturer. In addition:

1. Provide two sets of filters for each cabinet unit heater, properly packed and labeled.

2. Provide one motor for up to every 4 of same size motor for all heaters.

B. Tools: Provide standard and special tools and supplies necessary to service, disassemble, repair, and adjust the equipment.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All products provided under this Section shall be covered by a ten (10) year manufacturer warranty from Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Unit Heaters:

1. Trane Company, Long Island City, NY;
2. Modine Manufacturing Co., Racine, WI;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Unit Heaters:

1. General:
   a. The unit heater shall be complete with:
      1) Hot water coil.
      2) Fan.
      3) Motor.
      4) Fan Guard.
      5) Louver Fin Diffuser (for horizontal unit heaters).
      6) Casing.
   b. Each unit shall be provided with mounting bracket.
2. Coating:
   a. The entire unit including coil shall be coated internally and externally with a corrosion resistant phenolic coating.
   b. The coating on the entire unit shall be baked on.
3. Coils:
   a. The coils shall be constructed of aluminum fins permanently bonded to seamless copper tubes.
   b. The coils shall be suitable for pressure up to 200 psig and entering water temperatures up to 325°F inclusive.
   c. Coils shall be tested at a minimum of 300 psig air pressure under water.
4. Casing: The casing shall be constructed of heavy gauge steel.
5. Fan Wheels:
   a. Fan wheels shall consist of heavy gauge aluminum propeller type blades, statically and dynamically balanced at the speed at which the unit is scheduled to operate.
6. Drive:
   a. The fan shall be direct driven by a resiliently mounted, single speed, totally enclosed motor.
7. Motor:

a. Explosion-proof motors shall be provided where shown on the schedule on the Contract Drawings.

B. Cabinet Heaters:

1. General:

a. Provide cabinet heaters of the minimum size, heating and air capacities and arrangement shown.

2. Heating Element:

a. Shall be constructed of seamless copper tubes hydraulically expanded into aluminum plate fins to give a permanent bond.

3. Cabinets:

a. Construct cabinets of heavy gauge bonderized sheet steel, with a baked enamel finish of a standard color selected.

1) Construct front panels of die formed steel, with top inlet and bottom discharge grilles.

4. Blowers:

a. Construct blowers of aluminum, of the forward curved, centrifugal, double width, double inlet type, balanced to give quiet operation.

5. Motor and Drive:

a. Provide the permanent split capacitor type motor, 3-speed, with automatic overload protection and resilient base.

b. Provide the motor of the direct drive type with lubricated bearings, and with the speed selector switch mounted inside the cabinet.

6. Accessories:

a. Provide units complete with 1-in. thick fiberglass disposable type air filters, arranged for easy removal and replacement.

C. Electric Unit Heaters:

1. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

a. Provide unit mounted factory-installed power disconnect switch.

1) 15-Amp for heaters rated 12-Amps or lower

2) 30-Amp for heaters rated between 13- to 24-Amps

3. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

4. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

6. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

7. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

8. Fan: Aluminum propeller directly connected to motor.

9. Motor: Permanently lubricated.

10. Factory installed and prewired control options are to be supplied: adjustable built-in thermostat, fan only switch, pilot light to indicate abnormal operation.

D. Explosion-Proof, Electric Unit Heaters:

1. Explosion proof, electric unit heaters shall be fan-forced type, UL Approved for Class I, Divisions 1 and 2, Group C and D; Class II, Divisions 1 and 2, Groups E, F and G.

2. Assembly including chassis, liquid-to-air heating coil, fan, motor, and controls. Comply with UL 2021.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   a. Provide unit mounted factory-installed power disconnect switch.

      1) 15-Amp for heaters rated 12-Amps or lower

      2) 30-Amp for heaters rated between 13- to 24-Amps

4. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

5. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

7. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

8. The heat exchanger shall be liquid-to-air design, utilizing a steel tube core with integral aluminum fins. Nontoxic, inhibited, propylene glycol heat transfer fluid shall be used that provides freeze protection down to -49 deg F.

   a. A Pressure relief plug shall be utilized to provide overpressure protection. The heat exchanger shall include industrial grade electric heating elements.

9. Fan: Aluminum propeller directly connected to motor.

10. Motor: motor shall include permanently lubricated ball bearings and built-in thermal overload protection. Motor to operate at line voltage and be prewired to the control enclosure to eliminate the need for separate field wiring to the motor.

11. Factory installed and prewired control options are to be supplied: adjustable built-in thermostat, fan only switch, pilot light to indicate abnormal operation.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Identification:

1. Provide in accordance with Section 23 05 53, Identification for HVAC Piping and Equipment and Section 40 05 97, Identification for Process Equipment.

2. Each unit of equipment shall be identified with the equipment item numbers shown on the Contract Drawings.

3. A corrosion resistant tag and nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, to complete identification.

B. Coatings:

1. All exterior and interior metal surfaces of unit heaters (except coils) shall be factory primed and factory painted in accordance with Section 09 91 00, Painting.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. All unit heaters shall be as efficient as those have been tested to perform satisfactorily for at least two (2) years and providing equipment, which functions together as a system.

B. Shop Tests:

1. All shop tests shall be witnessed by a licensed Professional Engineer.

2. The licensed Professional Engineer shall sign and seal all test reports.

a. The state of the Professional Engineer's registration, the Professional Engineer's license number, and the Professional Engineer's name on the seal shall be clearly legible.

3. Procedure:

a. Shop test motors in accordance with Section 26 05 91, Low-Voltage Electric Motors.

b. Coils shall be shop tested at a minimum of 300 psig air pressure under water.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspection:

1. The Contractor shall not install damaged items until repairs are made in accordance with manufacturer's written instructions and approval by Engineer.

a. Only minor repair work will be permitted in the field.

b. All damaged items requiring remedial work shall be returned to the manufacturer for repair or replacement.

3.02 INSTALLATION

A. Install unit heaters in complete accordance with the manufacturer's printed installation instructions and the approved shop drawings.

3.03 FIELD TESTING / QUALITY CONTROL

A. Furnish the services of a qualified manufacturer's representative to check and approve all installations before operation in accordance with the requirements of the Contract documents. In addition:

1. The Contractor shall verify that all work furnished and installed conforms to the requirements of the Contract Documents.

B. All tests shall be performed in accordance with Section 23 05 93, Testing, Adjusting and Balancing for HVAC.

3.04 STARTUP / DEMONSTRATION

A. Furnish the service of a qualified manufacturer representative to assist and train the plant operations and maintenance staff in the care, operation, and maintenance of the unit heaters in accordance with the requirements of the Contract Documents. In addition:

1. The Contractor shall make all adjustments required to place Work in proper operating condition.

2. The Contractor shall include instruction on care and maintenance of the convectors in the training of plant personnel.

3. In the event of trouble with the equipment, the manufacturer's representative shall revisit the Site as often as required until all troubles are corrected and the installation is entirely satisfactory.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjusting:

1. Upon completion of the installation, the Contractor shall adjust all the unit heaters for their intended use.

2. Set air deflectors for proper air delivery.

3. Check room thermostat and wiring connections to unit heater.

4. Check return air thermostat and connections to cabinet unit heater.

B. Protection of Finished Work:

1. Unit heaters shall be protected as per the requirements of the Contract Documents. The use of unit heaters shall not be permitted until permission is given by the Engineer.

a. When permission is given, the Contractor shall operate each convector to ensure their performance.

C. Cleaning:

1. In addition to the requirements of the Contract Documents, the Contractor shall thoroughly clean all surfaces of the installed unit heaters and remove all debris and waste materials resulting from installation.

2. Clean work as specified in the Contract Documents.

END OF SECTION