SECTION 23 0513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single phase electric motors.

B. Three phase electric motors.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers.

C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.

D. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

D. Operation Data: Include instructions for safe operating procedures.

E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

B. Conform to NFPA 70, and State Energy Code.

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Lincoln Motors

B. A. O. Smith Electrical Products Co

C. Reliance Electric/Rockwell Automation

D. Baldor Electric Co.

E. U.S. Motor

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:

1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.

2. Motors Larger than 1/2 Horsepower: 208 or 460 volts, 3-phase, 60 Hz.

B. Construction:

1. Open drip-proof type except where specifically noted otherwise.

2. Design for continuous operation in 40 degrees C environment.

3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

4. Motors with frame sizes 254T and larger: Energy Efficient Type.

C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

F. Except as otherwise specified, motors shall be dripproof. Motors for belt drives shall have sliding bases.

G. All motors associated with variable frequency drives (VFD) shall be inverter duty type, and shall comply with NEMA MG-1, Part 3.1. Insulation shall be Class F or better. Temperature rise at full load with sine wave power shall not exceed Class B temperature limit. Thermal cut-out switch shall be "Klixon" type. Motor service factor shall be 1.0 when operating from variable frequency drive. Nameplate shall have markings as "inverter duty motor".

2.03 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not conform to these specifications.

B. Single phase motors for shaft mounted fans, oil burners and centrifugal pumps: Split phase type.

C. Single phase motors for shaft mounted fans or blowers and fan-powered VAV boxes: Permanent split capacitor type.

D. Single phase motors for fans, blowers and pumps: Capacitor start, capacitor run type.

E. Motors located in exterior locations, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, and explosion-proof environments: Totally enclosed type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To NEMA MG 1.

K. Part Winding Start: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

L. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

M. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

3.02 SCHEDULE

A. NEMA Open Motor Service Factors.

1. 1/6-1/3 hp:

    a. 3600 rpm: 1.35.

    b. 1800 rpm: 1.35.

    c. 1200 rpm: 1.35.

    d. 900 rpm: 1.35.

2. 1/2 hp:

    a. 3600 rpm: 1.25.

    b. 1800 rpm: 1.25.

    c. 1200 rpm: 1.25.

    d. 900 rpm: 1.15.

3. 3/4 hp:

    a. 3600 rpm: 1.25.

    b. 1800 rpm: 1.25.

    c. 1200 rpm: 1.15.

    d. 900 rpm: 1.15.

4. 1 hp:

    a. 3600 rpm: 1.25.

    b. 1800 rpm: 1.15.

c. 1200 rpm: 1.15.

d. 900 rpm: 1.15.

5. 1.5-150 hp:

a. 3600 rpm: 1.15.

b. 1800 rpm: 1.15.

c. 1200 rpm: 1.15.

d. 900 rpm: 1.15.

B. Three Phase - Energy Efficient, Open Drip-Proof Performance:

1. 1200 rpm.

a. 1 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 72.
3) Minimum Percent Efficiency: 81.

b. 1-1/2 hp:

1) NEMA Frame: 182T.
2) Minimum Percent Power Factor: 73.
3) Minimum Percent Efficiency: 83.

c. 2 hp:

1) NEMA Frame: 184T.
2) Minimum Percent Power Factor: 75.
3) Minimum Percent Efficiency: 85.

d. 3 hp:

1) NEMA Frame: 213T.
2) Minimum Percent Power Factor: 60.
3) Minimum Percent Efficiency: 86.

e. 5 hp:

1) NEMA Frame: 215T.
2) Minimum Percent Power Factor: 65.

3) Minimum Percent Efficiency: 87.

f. 7-1/2 hp:

1) NEMA Frame: 254T.
2) Minimum Percent Power Factor: 73.
3) Minimum Percent Efficiency: 89.

g. 10 hp:

1) NEMA Frame: 256T.
2) Minimum Percent Power Factor: 74.
3) Minimum Percent Efficiency: 89.

h. 15 hp:

1) NEMA Frame: 284T.
2) Minimum Percent Power Factor: 77.
3) Minimum Percent Efficiency: 90.

i. 20 hp:

1) NEMA Frame: 286T.
2) Minimum Percent Power Factor: 78.
3) Minimum Percent Efficiency: 90.

j. 25 hp:

1) NEMA Frame: 324T.
2) Minimum Percent Power Factor: 74.
3) Minimum Percent Efficiency: 91.

2. 1800 rpm.

a. 1 hp:

1) NEMA Frame: 143T.
2) Minimum Percent Power Factor: 84.
3) Minimum Percent Efficiency: 82.

b. 1-1/2 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 84.

c. 2 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 84.

d. 3 hp:

1) NEMA Frame: 182T.
2) Minimum Percent Power Factor: 86.
3) Minimum Percent Efficiency: 86.

e. 5 hp:

1) NEMA Frame: 184T.
2) Minimum Percent Power Factor: 87.
3) Minimum Percent Efficiency: 87.

f. 7-1/2 hp:

1) NEMA Frame: 213T.
2) Minimum Percent Power Factor: 86.
3) Minimum Percent Efficiency: 88.

g. 10 hp:

1) NEMA Frame: 215T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 89.

h. 15 hp:

1) NEMA Frame: 256T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 91.

i. 20 hp:

1) NEMA Frame: 256T.
2) Minimum Percent Power Factor: 86.
3) Minimum Percent Efficiency: 91.

3. 3600 rpm.

a. 1-1/2 hp:

1) NEMA Frame: 143T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 82.

b. 2 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 87.
3) Minimum Percent Efficiency: 82.

c. 3 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 84.

d. 5 hp:

1) NEMA Frame: 182T.
2) Minimum Percent Power Factor: 86.
3) Minimum Percent Efficiency: 85.

e. 7-1/2 hp:

1) NEMA Frame: 184T.
2) Minimum Percent Power Factor: 88.
3) Minimum Percent Efficiency: 86.

f. 10 hp:

1) NEMA Frame: 213T.
2) Minimum Percent Power Factor: 86.
3) Minimum Percent Efficiency: 87.

g. 15 hp:

1) NEMA Frame: 215T.
2) Minimum Percent Power Factor: 89.
3) Minimum Percent Efficiency: 89.

h. 20 hp:

1) NEMA Frame: 254T.
2) Minimum Percent Power Factor: 89.
3) Minimum Percent Efficiency: 90.

C. Three Phase - Energy Efficient, Totally Enclosed, Fan Cooled Performance:

1. 1200 rpm.

a. 1 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 72.
3) Minimum Percent Efficiency: 81.

b. 1-1/2 hp:

1) NEMA Frame: 182T.
2) Minimum Percent Power Factor: 73.
3) Minimum Percent Efficiency: 83.

c. 2 hp:

1) NEMA Frame: 184T.
2) Minimum Percent Power Factor: 68.
3) Minimum Percent Efficiency: 85.

d. 3 hp:

1) NEMA Frame: 213T.
2) Minimum Percent Power Factor: 63.
3) Minimum Percent Efficiency: 86.

e. 5 hp:

1) NEMA Frame: 215T.
2) Minimum Percent Power Factor: 66.
3) Minimum Percent Efficiency: 86.

f. 7-1/2 hp:

1) NEMA Frame: 254T.
2) Minimum Percent Power Factor: 68.
3) Minimum Percent Efficiency: 89.

g. 10 hp:

1) NEMA Frame: 256T.
2) Minimum Percent Power Factor: 75.
3) Minimum Percent Efficiency: 89.

h. 15 hp:

1) NEMA Frame: 284T.
2) Minimum Percent Power Factor: 72.
3) Minimum Percent Efficiency: 90.

i. 20 hp:

1) NEMA Frame: 286T.
2) Minimum Percent Power Factor: 76.
3) Minimum Percent Efficiency: 90.

2. 1800 rpm.

a. 1 hp:

1) NEMA Frame: 143T.
2) Minimum Percent Power Factor: 84.
3) Minimum Percent Efficiency: 82.

b. 1-1/2 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 84.

c. 2 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 84.

d. 3 hp:

1) NEMA Frame: 182T.
2) Minimum Percent Power Factor: 83.
3) Minimum Percent Efficiency: 87.

e. 5 hp:

1) NEMA Frame: 184T.
2) Minimum Percent Power Factor: 83.
3) Minimum Percent Efficiency: 88.

f. 7-1/2 hp:

1) NEMA Frame: 213T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 89.

g. 10 hp:

1) NEMA Frame: 215T.
2) Minimum Percent Power Factor: 84.
3) Minimum Percent Efficiency: 90.

h. 15 hp:

1) NEMA Frame: 254T.
2) Minimum Percent Power Factor: 86.
3) Minimum Percent Efficiency: 91.

i. 20 hp:

1) NEMA Frame: 256T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 91.

3. 3600 rpm.

a. 1-1/2 hp:

1) NEMA Frame: 143T.
2) Minimum Percent Power Factor: 85.
3) Minimum Percent Efficiency: 82.

b. 2 hp:

1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 87.
3) Minimum Percent Efficiency: 82.

c. 3 hp:

1) NEMA Frame: 182T.
2) Minimum Percent Power Factor: 87.
3) Minimum Percent Efficiency: 82.

d. 5 hp:

1) NEMA Frame: 184T.
2) Minimum Percent Power Factor: 88.
3) Minimum Percent Efficiency: 85.

e. 7-1/2 hp:

1) NEMA Frame: 213T.
2) Minimum Percent Power Factor: 86.
3) Minimum Percent Efficiency: 86.

f. 10 hp:

1) NEMA Frame: 215T.
2) Minimum Percent Power Factor: 86.
3) Minimum Percent Efficiency: 87.

g. 15 hp:

1) NEMA Frame: 254T.
2) Minimum Percent Power Factor: 91.
3) Minimum Percent Efficiency: 88.

h. 20 hp:

1) NEMA Frame: 256T.
2) Minimum Percent Power Factor: 89.
3) Minimum Percent Efficiency: 89.

END OF SECTION 23 0513

SECTION 23 0529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the following hangers and supports for HVAC system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Equipment supports.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ASME B31.9 - Building Services Piping; American Society of Mechanical Engineers.

B. ASME BPV (IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; American Society of Mechanical Engineers.

C. ASTM A36/A36M - Carbon Structural Steel; American Society for Testing and Materials.

D. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; American Society for Testing and Materials.

E. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation; American Society for Testing and Materials.

F. ASTM C1107 - Packaged Dry, Hydraulic-Cement Grout (Non-shrink); American Society for Testing and Materials.

G. AWS D1.1 - Structural Welding Code - Steel; American Welding Society.

H. AWS D1.2 - Structural Welding Code - Aluminum; American Welding Society.

I. AWS D1.4 - Structural Welding Code - Reinforcing Steel; American Welding Society.

J. MFMA-4 - Metal Framing Standards; Metal Framing Manufacturers Association.

K. MFMA-103 - Guidelines for the Use of Metal Framing; Metal Framing Manufacturers Association.

L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry.

M. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry.

N. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry.

O. SSPC-PA1 - Paint Application Standard for Shop, Field and Maintenance Painting of Steel; Society for Protective Coatings; latest edition.

1.04 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.05 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

D. Piping systems shall be supported so as to maintain required pitch of pipes, prevent vibration, and provide for expansion and contraction movement.

1.06 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.

2. Fiberglass pipe hangers.

3. Thermal-hanger shield inserts.

4. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.

2. Metal framing systems. Include Product Data for components.

3. Fiberglass strut systems. Include Product Data for components.

4. Equipment supports.

1.07 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel." and ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code-Steel."

2. AWS D1.2, "Structural Welding Code-Aluminum."

3. AWS D1.4, "Structural Welding Code-Reinforcing Steel."

4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

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

2.02 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. AAA Technology & Specialties Co., Inc.

2. Bergen-Power Pipe Supports.

3. B-Line Systems, Inc.; a division of Cooper Industries.

4. Carpenter & Paterson, Inc.

5. Empire Industries, Inc.

6. ERICO/Michigan Hanger Co.

7. Globe Pipe Hanger Products, Inc.

8. Grinnell Corp.

9. GS Metals Corp.

10. National Pipe Hanger Corporation.

11. PHD Manufacturing, Inc.

12. PHS Industries, Inc.

13. Piping Technology & Products, Inc.

14. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

A. Description: MFMA-4, shop or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.

3. GS Metals Corp.

4. Power-Strut Div.; Tyco International, Ltd.

5. Thomas & Betts Corporation.

6. Tolco Inc.

7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.05 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.

2. ERICO/Michigan Hanger Co.

3. PHS Industries, Inc.

4. Pipe Shields, Inc.

5. Rilco Manufacturing Company, Inc.

6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. Hilti, Inc.

b. ITW Ramset/Red Head.

c. Masterset Fastening Systems, Inc.

d. MKT Fastening, LLC.

e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.

b. Empire Industries, Inc.

c. Hilti, Inc.

d. ITW Ramset/Red Head.

e. MKT Fastening, LLC.

f. Powers Fasteners.

2.07 EQUIPMENT SUPPORTS

A. Description: Welded, shop or field-fabricated equipment support made from structural-steel shapes.

2.08 ROOFTOP EQUIPMENT SUPPORTS

A. Description: Monolithic construction, 18 gauge galvanized steel, continuous mitered and welded corner seams, integral base plate, factory installed wood nailer, and 18 gauge galvanized steel counterflashing.

B. Units shall be designed for installation on insulated decks with heights as required for the item supported.

C. Roof curbs for roof duct penetrations shall have 1-1/2-inch thick, 3 lb. rigid insulation, and a minimum height of 12-inches.

D. Units shall be installed in strict conformance to manufacturer's recommendations. Units shall sit on roof deck, not on roofing material. Provide flashing, counterflashing and hot mopping as required to assure a watertight installation.

E. Units shall be furnished by the mechanical contractor and turned over to the general contractor for installation by the general contractor.

F. Units shall be constructed to maintain equipment dead level.

G. Manufacturers:

1. Pate

2. Roof Products and Systems Corp.

3. ThyCurb

2.09 PIPE PENETRATION ROOF CURB

A. Pipe penetration curbs shall be of the same construction as the prefabricated equipment supports, including rigid insulation for duct penetration curbs. Units shall include 20 gauge counterflashing cap with 1-1/2-inch insulation. Curb shall be designed for horizontal pipe penetrations.

B. Provide with the curb the appropriate number of pipe covers, rubber and stainless steel clamps.

C. Units shall be furnished by the mechanical contractor, but turned over to the general contractor for installation by the general contractor.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

    b. Medium (MSS Type 32): 1500 lb.

    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

   a. Horizontal (MSS Type 54): Mounted horizontally.

   b. Vertical (MSS Type 55): Mounted vertically.

   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.02 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes for interior application. Install rooftop equipment supports per manufacturer's instructions.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

Q. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert. Provide continuous vapor barrier.

    c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

    b. NPS 4: 12 inches long and 0.06 inch thick.

    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 0529

SECTION 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Inertia bases.

B. Vibration isolators.

C. Seismic restraints.

D. Expected sound levels.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 SUBMITTALS

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

B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Detail bases and select based on lowest operating speed of equipment. Indicate seismic control measures with load calculations, spacing, location and strut types.

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

1.04 APPLICABLE REQUIREMENTS

A. Expected noise levels in various parts of the building shall conform to noise criteria recommendations set forth in the 2015 ASHRAE Handbook of HVAC Applications, Chapter 48.

B. Equipment shall be selected so that RC(N) levels shall not exceed the following ranges:

Suites	30 to 35
Meeting/Banquet	30 to 35
Service/Support	40 to 45
Corridors	40 to 45

C. An allowance not to exceed 5 dB may be added to the measured sound value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design conditions after occupancy, which may include the addition of sound absorbing materials, such as furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room, and sound pressure level in room.

D. Allowable vibration tolerances for rotating, non-reciprocating equipment shall not exceed a self-excited vibration maximum velocity of 0.20-inch per second RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions, or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

1.05 APPLICATION

A. Provide vibration isolators for all rotating and reciprocating equipment.

B. Provide spring hangers for all piping within Mechanical Room that is connected to rotating equipment.

C. For equipment which has no sound power ratings scheduled on the drawings, the contractor shall select equipment such that the noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook 2013, Chapter 8, Sound and Vibration.

D. Provide seismic restraints as indicated, and as follows:

1. All mechanical equipment not supported with isolators external to the unit shall be securely anchored to the structure. Such mechanical equipment shall be properly supported to resist a horizontal force, as determined in accordance with the International Building Code (IBC).

2. All mechanical equipment mounted on vibration isolators shall be provided with seismic restraints capable of resisting a horizontal force, as determined in accordance with the IBC.

E. Provide flexible duct connections at all air handling equipment, even if they are provided with internal fan isolation, and at the inlet and discharge of all fans.

F. Provide flexible piping connections at chillers, condensers, cooling towers, air handling units and pumps.

1.06 RELATED DOCUMENTS

A. For seismic requirements by building type, hazard exposure and location, refer to the International Building Code (IBC), latest edition.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Isolation Technology, Inc.

B. Kinetics Noise Control, Inc.

C. Mason Industries

D. Korfund/VMC

E. Amber -Booth

F. Vibration Eliminator Company

2.02 TECHNICAL REQUIREMENTS

A. Equipment driven by motors, 2 horsepower and smaller, shall be isolated by means of elastomeric mounts or elastomeric hangers, sized for 1/2-inch deflection. Larger equipment shall be isolated by means of open spring mounts or open spring hangers, sized for the specified deflection.

B. Steel components shall be phosphatized and painted. Nuts, bolts and washers shall be zinc electroplated. Structural steel bases shall be cleaned of welding slag and primed with zinc chromate or metal etching primer.

C. Isolators exposed to the weather shall have steel parts PVC coated or minimum of G-90 hot-dip galvanized. Aluminum components shall be etched and painted. Nuts, bolts and washers may be zinc electroplated.

D. Elastomeric components shall be of neoprene or synthetic rubber with anti-ozone and anti-oxidant additives.

2.03 INERTIA BASES

A. Structural Bases (Type R):

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

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

B. Concrete Inertia Bases (Type I):

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

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

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

4. Concrete: Minimum 3000 psi concrete.

2.04 VIBRATION ISOLATORS

A. Open Spring Isolators (Type S, SP):

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

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

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

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

B. Spring Hanger (Type H, HS):

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

2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, or rubber hanger with threaded insert.

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

C. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

D. Seismic Snubbers:

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

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

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

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

E. Roof Mounting Curb: Minimum 14 inches high with rigid steel lower section containing adjustable spring pockets with restrained spring isolators, steel upper section to support rooftop equipment, and continuous elastomeric membrane extending from upper section for counterflashing over roofing. Provide acoustical package consisting of interior perimeter angles and cross members to support up to two layers of gypsum board. Where the curb is specified to act as a plenum, provide flexible membrane plenum dividers to form an airtight seal. The curb shall be provided with duct supports, sized to match the unit manufacturer's inlet and outlet duct connections. Provide curb manufacturer's certification that the curb is in compliance with seismic loading requirements.

F. Resilient Pipe Guide: Steel clamp and neoprene mount. Provide where piping rises vertically through floor slabs. Equal to VMC Series RPG.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions. No metal-to-metal contact will be permitted between fixed and floating parts.

B. Bases:

1. Set steel bases for 1 inch clearance between housekeeping pad and base.

2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

3. Adjust equipment level.

C. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

E. Provide pairs of horizontal limit springs (thrust restraints, Type THR) on fans with more than 4.0 inches w.c. static pressure, and on hanger supported, horizontally mounted axial fans.

F. Provide seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 0.05 inch maximum clearance. Other snubbers shall have clearance between 0.15 inch and 0.25 inch.

G. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for scheduled distance, to nearest flexible pipe connector, or as follows:

1. Up to 4 Inches Pipe Size: First three points of support.

2. 5 to 8 Inches Pipe Size: First four points of support.

3. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.02 FIELD QUALITY CONTROL

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

B. In high wind areas, provide uplift resistance on spring isolators exposed to weather.

3.03 SCHEDULE

A. Pipe Isolation Schedule.

1. 1 Inch Pipe Size: Isolate 120 diameters from equipment.

2. 2 Inch Pipe Size: Isolate 90 diameters from equipment.

3. 3 Inch Pipe Size: Isolate 80 diameters from equipment.

4. 4 Inch Pipe Size: Isolate 75 diameters from equipment.

B. Vibration isolators shall be installed where specified herein and where shown on the drawings, and as follows:

Equipment Type	**Slab on Grade**			**Structural Spans up to 30-Feet Between Columns**		
	Base Deflection	Isolator	Min.	Base Deflection	Isolator	Min.
Heat pumps	---		S,H	---		S,H
	0.75"			0.75"		
Condensing Units	---		P	---		SP
	0.25"			1.50"		
Air handling units/H&V unit, up to 4" TSP	---		S,SP	---	S,SP	1.50"
	0.75"					
Air handling units/H&V units, 4" TSP and up	R		S,SP	I		S,SP
	0.75"			2.50"		

Packaged rooftop units	Curb 0.25"	P	Curb	S,SP	2.50"
Piping in Mechanical Rooms	--- 1.00"	H	---	H	1.00"
Centrifugal fan up to 22" wheel (floor-mounted)	R 0.25"	M	R 0.75"		S
Centrifugal fan up to 22" wheel (suspended)	--- ---	---	R 0.75"		H
Centrifugal fan 24" wheel and up (floor-mounted)	R 1.50"	S	R	S,SP	1.50"
Centrifugal fan 24" wheel and up (suspended)	--- ---	---	R	H,HS	1.50"

C. Mount thrust restraints at the horizontal centerline of the air flow. Provide mounting brackets on both sides of flexible connection at fan discharge.

D. Vibration isolators for small fans, air handling units and refrigerant compressors may be supplied as part of packaged equipment.

END OF SECTION 23 0548

SECTION 23 0549 - SEISMIC RESTRAINTS FOR SUSPENDED UTILITIES AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers seismic restraints for suspended utilities including HVAC Ductwork, HVAC Piping, Plumbing, Electrical Systems (conduits, cable tray, bus duct, etc.), Fire Suppression Systems and Fuel Piping.

B. Anchorage calculations are required for all equipment in accordance with IBC 2006.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 SEISMIC BRACING

A. 2006 International Building Code Section 1631 Earthquake Loads

B. ASCE 7-05 Chapter 13 (Formulas 13.3.1, 13.3-2 and 13.3-3)

C. 2006 International Building Code Chapter 17 Structural Tests and Special Inspections.

1.04 SUBMITTALS

A. Seismic restraints shall be designed by a registered structural engineer in accordance with the 2006 IBC and ASCE 7-05. Those systems and components that require seismic restraints are noted in section 1.04.

B. Submittals shall include appropriate details and reflect actual job site conditions. Submittal shall be wet stamped by a registered structural engineer specialized in the design of seismic restraints and licensed in the state where the project is located.

C. Job site conditions not covered by the manufacturer's design manual shall be engineered on an individual basis and all calculations and details shall be wet stamped by a registered structural engineer specialized in the design of seismic restraints and licensed in the state where the project is located.

D. Submit seismic bracing layouts for all suspended utilities on shop drawings wet stamped by a registered structural engineer specialized in the design of seismic restraints and licensed in the state where the project is located. The basis for the layouts shall be the utility contractors shop drawings, and the addition of the bracing locations shall be the responsibility of this section.

E. Layout drawings to include:

1. All vertical support and seismic bracing locations.

2. All vertical support and seismic bracing connections to the structure (Anchorage Manufacturer, Quantity and Size for each location).

3. Vertical Support and brace arm reactions at all connection points to the structure (for the Structural Engineer of Record use in checking suitability of the building structure).

4. Type and size of brace member.

5. Reference installation detail numbers for vertical support and seismic bracing.

6. Maximum Transverse and Longitudinal brace spacing for each utility.

7. Seismic accelerations each utility has been designed to resist.

8. Suspended utility maximum weight per lineal foot (lbs/1f) or maximum pipe/conduit size at all seismic locations.

9. Maximum all threaded rod size at all seismic locations.

1.05 SPECIFICATION QUALITY ASSURANCE & SPECIAL INSPECTION

A. Where the Component Importance Factor (Ip) is greater than 1.0 for any mechanical, electrical, component or system, that system is considered to be a "Designated Seismic System" per Chapter 17 of the 2006 IBC. Each Contractor responsible for the construction of a Designated Seismic System shall submit a written "statement of responsibility", per the 2006 IBC (Section 1706), to the building official and owner prior to the commencement of work on the system or component.

B. Install Identification tags at all seismic brace locations to include the following:

1. The specific seismic forces (g force) the location was designed to resist.

2. Maximum brace reaction to the structure.

3. Maximum pipe/conduit size the brace location was designed for (individually suspended items).

4. Maximum weight (lbs/1f) the brace location was designed for (trapeze utility locations).

5. Maximum weight the brace location was designed for (all suspended equipment).

6. Nomenclature that matches location identification as marked on plan set layout.

C. Upon completion of construction a Quality Assurance Representative of the seismic force resisting system manufacturer/designer shall review the installation of the seismic-force-resisting system and provide documentation indicating conformance to shop drawing seismic restraint layout.

D. Special Inspection will be required on Designated Seismic Systems per the Statement of Special Inspections submitted at time of permit application and/or Section 1705.3 and Section 1707.8 of the 2006 IBC.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers & Materials

1. Acceptable Manufacturers:

a. ISAT (International Seismic Application Technology)

b. Unistrut

c. Tolco

d. B-line

2. Material Requirements:

a. All manufacturer specific components that are part of the seismic resistance system must be strength tested by independent structural test facility, with test reports available upon request. (Tests by the component manufacturer are not acceptable.)

b. All anchors utilized as part of the component anchorage and/or seismic anchorage must comply with Section 13.4.2 of the ASCE 7.05. Specifically all anchors must be tested for seismic applications in conformance with ACI 355.2.

2.02 SPECIFICATION DEVIATIONS

A. Any contractor or manufacturer wishing to deviate from the project code requirements must submit in writing the following:

1. Deviation requested

2. Reason for the deviation to include code or local jurisdiction allowances.

3. Cost impact for deviation

B. A manufacturer's letter of exception will not be considered acceptable justification for deviations. Deviations citing differences between SMACNA and IBC/ASCE exclusions as reasoning for deviation will not be considered.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All seismic bracing shall be installed per the manufacturer's instruction sheet supplied in each bracing kit.

B. Torque each anchor bolt in accordance with manufacturer's instruction sheet supplied with each bracing kit.

END OF SECTION 23 0549

SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers.

1.04 SUBMITTALS

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

B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

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

D. Samples: Submit two labels and two valve tags.

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

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Brady Corporation

B. Champion America, Inc.

C. Seton Identification Products

D. Marking Services, Inc. (MSI)

2.02 NAMEPLATES

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

1. Letter Color: White.

2. Letter Height: 1/2 inch.

3. Background Color: Black, Red, Green, Yellow, or as directed.

2.03 TAGS

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

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

C. Chart: Typewritten letter size list in anodized aluminum frame.

2.04 STENCILS

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

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

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

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

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

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

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

B. Stencil Paint: Semi-gloss enamel, colors conforming to ASME A13.1.

2.05 PIPE MARKERS

A. Color: Conform to ASME A13.1.

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

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

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

2.06 CEILING TACKS

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

B. Color code as follows:

1. Yellow - HVAC equipment

2. Red - Fire dampers/smoke dampers

3. Blue - Heating/cooling valves

PART 3 - EXECUTION

3.01 PREPARATION

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

B. Prepare surfaces for stencil painting.

3.02 INSTALLATION

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

B. Install tags with corrosion resistant chain.

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

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

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates or stencil painting. Small devices, such as in-line pumps, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify thermostats relating to terminal boxes or valves with nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units and radiator valves with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers, or stenciled painting. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. Identify ductwork with plastic nameplates, or stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

N. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

O. Provide non-fading weatherproof (metal) nameplate on all mechanical equipment exposed to the weather. If manufacturer does not provide suitable nameplate, contractor shall provide and affix nameplate to the equipment, listing make, model number, serial number, and relevant capacity and electrical data.

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

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

B. Testing, adjustment, and balancing of refrigerating systems.

C. Measurement of final operating condition of HVAC systems.

D. Sound measurement of equipment operating conditions.

E. Vibration measurement of equipment operating conditions.

F. Commissioning activities.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 ALLOWANCES

A. Allowance includes testing, adjusting, and balancing of mechanical systems.

1.04 REFERENCES

A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council.

B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association.

1.05 SUBMITTALS

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

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

1. Submit to Architect.

2. Submit to the Commissioning Authority, Construction Manager, and HVAC controls contractor.

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

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

5. Include at least the following in the plan:

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

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

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

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

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

f. Final test report forms to be used.

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

1) Terminal flow calibration (for each terminal type).
2) Diffuser proportioning.
3) Branch/submain proportioning.
4) Total flow calculations.
5) Rechecking.
6) Diversity issues.

h. Expected problems and solutions, etc.

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

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

1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.

k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.

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

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

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

o. Proposed selection points for sound measurements and sound measurement methods.

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

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

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

s. Time schedule for deferred or seasonal TAB work, if specified.

t. False loading of systems to complete TAB work, if specified.

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

v. Interstitial cavity differential pressure measurements and calculations, if specified.

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

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

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

C. Field Logs: Submit at least once a week to Commissioning Authority, Construction Manager, and Architect; Engineer.

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

E. Progress Reports.

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

1. Submit to the Commissioning Authority, Construction Manager, and HVAC controls contractor within two weeks after completion of testing, adjusting, and balancing.

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

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

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

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

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

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

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

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

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

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

d. Project name.

e. Project location.

f. Project Architect.

g. Project Engineer.

h. Project Contractor.

i. Report date.

G. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

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

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

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

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

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

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

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

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

D. TAB Agency Qualifications:

1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of three years documented experience.

3. Certified by one of the following:

a. AABC, Associated Air Balance Council: upon completion submit AABC National Performance Guaranty.

b. NEBB, National Environmental Balancing Bureau.

c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute.

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

F. TAB Supervisor Qualifications: Professional Engineer licensed in the State in which the Project is located.

3.02 EXAMINATION

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

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

2. Temperature control systems are installed complete and operable.

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

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

5. Duct systems are clean of debris.

6. Fans are rotating correctly.

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

8. Air coil fins are cleaned and combed.

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

10. Air outlets are installed and connected.

11. Duct system leakage is minimized.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

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

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

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

C. Provide additional balancing devices as required.

3.04 INSTALLATION TOLERANCES

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

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

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:

1. Running log of events and issues.

2. Discrepancies, deficient or uncompleted work by others.

3. Contract interpretation requests.

4. Lists of completed tests.

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

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

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

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

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

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

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

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

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

C. Measure air quantities at air inlets and outlets.

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

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

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

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

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

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

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

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

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

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

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

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

P. Measure static pressure between laboratories, clean rooms and corridors. Adjust air flows to maintain pressure relationships indicated on the plans.

Q. Measure static pressure between patient isolation rooms, anterooms and corridors. Adjust air flows to maintain pressure relationships indicated on the plans.

3.07 COMMISSIONING

A. Perform prerequisites prior to starting commissioning activities.

B. Fill out Prefunctional Checklists for:

1. Air side systems.

C. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.

D. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 100 percent of the air handlers, plus a random sample equivalent to 20 percent of the final TAB report data as directed by Commissioning Authority.

1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.

2. Use the same test instruments as used in the original TAB work.

3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.

4. For purposes of re-check, failure is defined as follows:

   a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.

   b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.

   c. Temperatures: Deviation of more than 1 degree F.

   d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.

   e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.

5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.

E. In the presence of the Commissioning Authority, verify that:

1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.

2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.

3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

F. No seasonal tests are required.

G. No further monitoring is required.

H. No deferred testing is required.

3.08 SCOPE

A. Test, adjust, and balance the following:

1. Fire Pumps
2. Sprinkler Air Compressor
3. Electric Water Coolers
4. Plumbing Pumps
3. Direct Fired Furnaces
4. Air Cooled Refrigerant Condensers
5. Packaged Rooftop Heating/Cooling Units
6. Heat Pumps
7. Air Handling Units
8. Fans
9. Air Filters
10. Air Inlets and Outlets

3.09 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

1. Manufacturer
2. Model/Frame
3. HP/BHP
4. Phase, voltage, amperage; nameplate, actual, no load

5. RPM

6. Service factor

7. Starter size, rating, heater elements

8. Sheave Make/Size/Bore

B. V-Belt Drives:

1. Identification/location

2. Required driven RPM

3. Driven sheave, diameter and RPM

4. Belt, size and quantity

5. Motor sheave diameter and RPM

6. Center to center distance, maximum, minimum, and actual

C. Air Cooled Condensers:

1. Identification/number

2. Location

3. Manufacturer

4. Model number

5. Serial number

6. Entering DB air temperature, design and actual

7. Leaving DB air temperature, design and actual

8. Number of compressors

D. Cooling Coils:

1. Identification/number

2. Location

3. Service

4. Manufacturer

5. Air flow, design and actual

6. Entering air DB temperature, design and actual

7. Entering air WB temperature, design and actual

8. Leaving air DB temperature, design and actual

9. Leaving air WB temperature, design and actual

10. Saturated suction temperature, design and actual

11. Air pressure drop, design and actual

E. Air Moving Equipment:

1. Location

2. Manufacturer

3. Model number

4. Serial number

5. Arrangement/Class/Discharge

6. Air flow, specified and actual

7. Return air flow, specified and actual

8. Outside air flow, specified and actual

9. Total static pressure (total external), specified and actual

10. Inlet pressure

11. Discharge pressure

12. Sheave Make/Size/Bore

13. Number of Belts/Make/Size

14. Fan RPM

F. Return Air/Outside Air:

1. Identification/location

2. Design air flow

3. Actual air flow

4. Design return air flow

5. Actual return air flow

6. Design outside air flow

7. Actual outside air flow

8. Return air temperature

9. Outside air temperature

10. Required mixed air temperature

11. Actual mixed air temperature

12. Design outside/return air ratio

13. Actual outside/return air ratio

G. Exhaust Fans:

1. Location

2. Manufacturer

3. Model number

4. Serial number

5. Air flow, specified and actual

6. Total static pressure (total external), specified and actual

7. Inlet pressure

8. Discharge pressure

9. Sheave Make/Size/Bore

10. Number of Belts/Make/Size

11. Fan RPM

H. Duct Traverses:

1. System zone/branch

2. Duct size

3. Area

4. Design velocity

5. Design air flow

6. Test velocity

7. Test air flow

8. Duct static pressure

9. Air temperature

10. Air correction factor

I. Duct Leak Tests:

1. Description of ductwork under test

2. Duct design operating pressure

3. Duct design test static pressure

4. Duct capacity, air flow

5. Maximum allowable leakage duct capacity times leak factor

6. Test apparatus

a. Blower

b. Orifice, tube size

c. Orifice size

d. Calibrated

7. Test static pressure

8. Test orifice differential pressure

9. Leakage

J. Air Monitoring Stations:

1. Identification/location

2. System

3. Size

4. Area

5. Design velocity

6. Design air flow

7. Test velocity

8. Test air flow

K. Air Distribution Tests:

1. Air terminal number

2. Room number/location

3. Terminal type

4. Terminal size

5. Area factor

6. Design velocity

7. Design air flow

8. Test (final) velocity

9. Test (final) air flow

10. Percent of design air flow

L. Sound Level Reports:

1. Location

2. Octave bands - equipment off

3. Octave bands - equipment on

M. Vibration Tests:

1. Location of points:

a. Fan bearing, drive end

b. Fan bearing, opposite end

c. Motor bearing, center (if applicable)

d. Motor bearing, drive end

e. Motor bearing, opposite end

f. Casing (bottom or top)

g. Casing (side)

h. Duct after flexible connection (discharge)

i. Duct after flexible connection (suction)

2. Test readings:

a. Horizontal, velocity and displacement

b. Vertical, velocity and displacement

c. Axial, velocity and displacement

3. Normally acceptable readings, velocity and acceleration

4. Unusual conditions at time of test

5. Vibration source (if non-complying)

END OF SECTION 23 0593

SECTION 23 0713 - DUCT INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Insulation jackets.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

C. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

D. ASTM C 553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

E. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

F. ASTM C 1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

G. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

H. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials.

I. ASTM G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

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

K. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.

L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.

M. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association.

1.04 SUBMITTALS

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

B. Samples: Submit two samples of any representative size illustrating each insulation type.

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

1.05 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND PROTECTION

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

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

1.07 ENVIRONMENTAL REQUIREMENTS

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

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

PART 2 - PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:

1. Knauf Fiber Glass

2. Johns Manville Corporation

3. Owens Corning Corp

4. CertainTeed Corporation;

B. Insulation: ASTM C 553; flexible, noncombustible blanket.

1. 'K' value: 0.30 at 75 degrees F, when tested in accordance with ASTM C 518.

2. Maximum Service Temperature: 450 degrees F.

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

C. Vapor Barrier Jacket:

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

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

3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive. Compatible with insulation manufacturer's vapor barrier.

E. Outdoor Vapor Barrier Mastic:

1. Manufacturers:

a. Foster Model Safetee HI.

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

F. Tie Wire: Annealed steel, 16 gage.

2.03 GLASS FIBER, RIGID

A. Manufacturer:

1. Knauf Fiber Glass

2. Johns Manville Corporation

3. Owens Corning Corp

4. CertainTeed Corporation;

B. Insulation: ASTM C 612; rigid, noncombustible blanket.

1. 'K' value: 0.24 at 75 degrees F, when tested in accordance with ASTM C 518.

2. Maximum service temperature: 450 degrees F.

3. Maximum Water Vapor Sorption: 5.0 percent.

4. Maximum Density: 8.0 lb./cu. ft.

C. Vapor Barrier Jacket:

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

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

3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive. Compatible with insulation manufacturer's vapor barrier.

2.04 KITCHEN GREASE HOOD EXHAUST DUCT INSULATION

A. All kitchen grease hood exhaust ducts shall be insulated with lightweight, non-asbestos, inorganic foil encapsulated ceramic fiber blanket duct wrap. The thickness of the duct wrap shall be as recommended by the manufacturer to provide the equivalent resistance characteristics of a 2-hour fire-rated shaft enclosure.

B. The duct wrap system shall be UL listed, and shall provide "zero inch" clearance to combustible materials in conformance with the latest edition of NFPA 96.

C. The duct wrap shall be installed in accordance with the manufacturer's instructions, and the requirements of NFPA 96.

D. The grease hood exhaust duct wrap system shall be 3M Fire Barrier Duct Wrap 15A, or similar product by CertainTeed, Pyroscat, or approved equal.

2.05 JACKETS

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

1. Lagging Adhesive:

a. Compatible with insulation.

B. Aluminum Jacket: ASTM B 209 (ASTM B 209M).

1. Thickness: 0.016 inch or 0.020 inch sheet.

2. Finish: Smooth.

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

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

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

6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Insulated ducts conveying air below ambient temperature:

1. Provide insulation with vapor barrier jackets.

2. Finish with tape and vapor barrier jacket.

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

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

5. Insulate body of all supply air diffusers and registers.

D. Insulated ducts conveying air above ambient temperature:

1. Provide with standard vapor barrier jacket.

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

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

F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

G. External Duct Insulation Application:

1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.

2. Seal joints, pins and washers with vapor barrier compound equal to Foster 60-25, reinforced with open mesh glass fiber, or approved method.

3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.

4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

H. Metal Corner Reinforcement:

1. Provide insulation stops and metal corner reinforcement at all openings in insulation for access doors, panels, control instruments, and damper operators.

2. Fabricate from galvanized steel, and finish with no raw edges showing.

I. Kitchen Grease hood Exhaust Duct Insulation: Apply ceramic fiber duct wrap in multiple layers, with staggered joints and continuous vapor barrier seal.

J. Provide 20-mil thickness PVC jacket on all ductwork, color as directed.

3.03 SCHEDULES

A. Combustion Air Duct:

1. Rigid Glass Fiber Duct Insulation: 3 inches thick.

2. Rigid Glass Fiber Duct Liner Insulation: 3 inches thick.

B. Exhaust Ducts Within 10 feet of Exterior Openings: Flexible wrap, 1-1/2 inches thick.

C. Exhaust Ducts Exposed to Outdoor Air: Rigid board, 2 inches thick.

D. Outside Air Intake Ducts: Rigid board, 3 inches thick.

E. Plenums: Rigid board, 2 inches thick.

F. Plenums (Cooling System): Rigid board, 2 inches thick.

G. Ventilation Equipment Casings: Rigid board, 2 inches thick.

H. Supply, Relief and Return Ducts in Mechanical Rooms: Rigid board, 2 inches thick.

I. Supply and Return Ducts From Fans to Vertical Ducts in Shafts: Rigid board, 2 inches thick.

J. Supply and Return Ducts in Vertical Shafts: Rigid board, 2 inches thick.

K. Supply ducts After Heat Pumps: Flexible wrap, 1-1/2 inches thick.

L. Low Temperature Supply Ducts (below 52 degrees F): Flexible wrap, 2-1/2 inches thick.

M. Ducts Exposed to Outdoors: Rigid board, 3 inches thick.

N. Return Ducts Above Ceilings: Flexible wrap, 1-1/2 inches thick.

O. Existing Insulation Damaged by New Work: Repair and seal to match existing thickness and conditions.

END OF SECTION 23 0713

SECTION 23 0716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Equipment insulation.

B. Covering.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

B. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

D. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

E. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

F. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

G. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

H. ASTM C 533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

I. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

J. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation.

K. ASTM C 553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

L. ASTM C 592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).

M. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

N. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

O. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials.

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

Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.

1.04 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

B. Samples: Submit two samples of any representative size illustrating each insulation type.

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

1.05 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND PROTECTION

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

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

1.07 ENVIRONMENTAL REQUIREMENTS

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

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

PART 2 - PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturers:

1. Knauf Fiber Glass

2. Johns Manville Corporation

3. Owens Corning Corp

4. CertainTeed Corporation

B. Insulation: ASTM C 553; flexible, noncombustible.

1. 'K' Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C 177 or ASTM C 518.

2. Maximum Service Temperature: 450 degrees F.

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

C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film or vinyl.

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

2. Secure with self-sealing longitudinal laps and butt strips.

3. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive:

1. Compatible with insulation.

F. Insulating Cement/Mastic:

1. ASTM C 195; hydraulic setting on mineral wool.

2.03 GLASS FIBER, RIGID

A. Manufacturer:

1. Knauf Fiber Glass

2. Johns Manville Corporation

3. Owens Corning Corp

4. CertainTeed Corporation

B. Insulation: ASTM C 612 or ASTM C 592; rigid, noncombustible.

1. 'K' Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C 177 or ASTM C 518.

2. Maximum Service Temperature: 850 degrees F.

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

4. Maximum Density: 8.0 lb./cu. ft.

C. Vapor Barrier Jacket:

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

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

3. Secure with self-sealing longitudinal laps and butt strips.

4. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Facing: 1 inch galvanized or stainless steel hexagonal wire mesh stitched on one face of insulation, onto both faces of insulation, or on one face of insulation with expanded metal lath on other.

E. Vapor Barrier Lap Adhesive:

1. Compatible with insulation.

F. Insulating Cement/Mastic:

1. ASTM C 195; hydraulic setting on mineral wool.

2.04 CELLULAR GLASS

A. Manufacturer:

1. Pittsburgh Corning Corporation

B. Insulation: ASTM C 552, Grade 2.

1. 'K' Value: 0.41 at 100 degrees F.

2. Service Temperature: Up to 900 degrees F.

3. Water Vapor Permeability: 0.005 perm inch.

4. Water Absorption: 0.2 percent by volume, maximum.

5. Density: Minimum 6.80 lb./cu. ft.

2.05 HYDROUS CALCIUM SILICATE

A. Manufacturer:

1. Johns Manville Corporation

B. Insulation: ASTM C 533; rigid molded, asbestos free, gold color.

1. 'K' Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C 177 or C518.

2. Maximum Service Temperature: 1200 degrees F.

3. Density: 15 lb./cu. ft.

C. Tie Wire: 0.048 inches stainless steel with twisted ends on maximum 12 inch centers.

D. Insulating Cement:

1. ASTM C 449/C 449M.

2.06 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

1. Armacell International

2. Rubatex.

3. Halstead.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3, in sheet form.

1. Minimum Service Temperature: -40 degrees F.

2. Maximum Service Temperature: 220 degrees F.

3. Connection: Waterproof vapor barrier adhesive.

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

2.07 JACKETS

A. PVC Plastic:

1. Manufacturers:

a. Johns Manville Corporation

2. Jacket: Sheet material, off-white color.

a. Minimum Service Temperature: -40 degrees F.

b. Maximum Service Temperature: 150 degrees F.

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

d. Thickness: Minimum 10 mil.

e. Connections: Brush on welding adhesive or Pressure sensitive color matching vinyl tape.

3. Covering Adhesive Mastic:

a. Compatible with insulation.

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

1. Lagging Adhesive:

    a. Compatible with insulation.

C. Aluminum Jacket: ASTM B 209 (ASTM B 209M) formed aluminum sheet.

1. Thickness: 0.016 inch sheet.

2. Finish: Smooth.

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

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

5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

D. Stainless Steel Jacket: ASTM A 666, Type 304 stainless steel.

1. Thickness: 0.010 inch.

2. Finish: Smooth.

3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

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

D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated equipment containing fluids below ambient temperature: Insulate entire system.

G. Fiber glass insulated equipment containing fluids below ambient temperature: Provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

J. Fiber glass insulated equipment containing fluids above ambient temperature: Provide standard jackets, with vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

K. Inserts and Shields:

1. Application: Equipment 1-1/2 inches diameter or larger.

2. Shields: Galvanized steel between hangers and inserts.

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

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

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

L. Finish insulation at supports, protrusions, and interruptions.

M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting, PVC jacket and fitting covers, aluminum jacket, or stainless steel jacket.

N. Exterior Applications: Provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

O. Cover glass fiber, cellular glass, hydrous calcium silicate, or cellular foam insulation with metal mesh and finish with heavy coat of insulating cement, aluminum jacket or stainless steel jacket.

P. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

Q. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

R. Existing insulation damaged by new work shall be repaired and finished to match original new condition.

3.03 SCHEDULE

A. Cooling Systems:

1. Equipment Exposed to Freezing with Heat Tracing: Rigid board, 3 inches thick

END OF SECTION 23 0716

SECTION 23 0719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

B. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

D. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.

E. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

F. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

G. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

H. ASTM C 533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

I. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

J. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation.

K. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation.

L. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

M. ASTM C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

N. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

O. ASTM C 610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.

P. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

Q. ASTM D 1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber.

R. ASTM D 2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.

S. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

T. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials.

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

V. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc..

1.04 SUBMITTALS

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

B. Samples: Submit two samples of any representative size illustrating each insulation type.

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

1.05 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND PROTECTION

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

1.07 ENVIRONMENTAL REQUIREMENTS

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

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

PART 2 - PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.02 GLASS FIBER

A. Manufacturers:

1. Knauf Fiber Glass

2. Johns Manville Corporation

3. Owens Corning Corp

4. CertainTeed Corporation

B. Insulation: ASTM C 547 rigid molded, noncombustible.

1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.

2. Maximum service temperature: 850 degrees F or 1200 degrees F.

3. Maximum moisture absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive:

1. Compatible with insulation.

F. Insulating Cement/Mastic:

1. ASTM C 195; hydraulic setting on mineral wool.

G. Fibrous Glass Fabric:

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

2. Blanket: 1.0 lb./cu. ft.

3. Weave: 5x5.

H. Indoor Vapor Barrier Finish:

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

2. Vinyl emulsion type acrylic, compatible with insulation, color as directed.

I. Outdoor Vapor Barrier Mastic:

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

J. Outdoor Breather Mastic:

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

K. Insulating Cement:

1. ASTM C 449/C 449M.

2.03 CELLULAR GLASS

A. Manufacturers:

1. Pittsburgh Corning Corporation

B. Insulation: ASTM C 552, Grade 1.

1. 'K' value: 0.37 at 100 degrees F.

2. Service Temperature: Up to 900 degrees F.

3. Water Vapor Permeability: 0.005 perm inch.

4. Water Absorption: 0.2 percent by volume, maximum.

2.04 HYDROUS CALCIUM SILICATE

A. Manufacturers:

1. Johns Manville Corporation

B. Insulation: ASTM C 533 and ASTM C 795; rigid molded, asbestos free, gold color.

1. 'K' value: ASTM C 177 and C518; 0.40 at 300 degrees F, when tested in accordance with ASTM C 177 or ASTM C 518.

2. Maximum service temperature: 1200 degrees F.

3. Density: 15 lb./cu. ft.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Insulating Cement:

1. ASTM C 449/C 449M.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

1. Armacell International

2. Rubatex

3. Halstead

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3; use molded tubular material wherever possible.

1. Minimum Service Temperature: -40 degrees F.

2. Maximum Service Temperature: 220 degrees F.

3. Connection: Waterproof vapor barrier adhesive.

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

2.06 JACKETS

A. PVC Plastic.

1. Manufacturers:

a. Johns Manville Corporation

2. Jacket: One piece molded type fitting covers and sheet material, off-white color.

a. Minimum Service Temperature: 0 degrees F.

b. Maximum Service Temperature: 150 degrees F.

c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.

d. Thickness: Minimum 10 mil.

e. Connections: Brush on welding adhesive, or pressure sensitive color matching vinyl tape.

3. Covering Adhesive Mastic:

a. Compatible with insulation.

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

1. Lagging Adhesive:

a. Compatible with insulation.

C. Aluminum Jacket: ASTM B 209 (ASTM B 209M) formed aluminum sheet.

1. Thickness: 0.016 inch sheet.

2. Finish: Smooth.

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

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

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

6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

D. Stainless Steel Jacket: ASTM A 666, Type 304 stainless steel.

1. Thickness: 0.010 inch.

2. Finish: Smooth.

3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

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

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

E. Glass fiber insulated pipes conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

H. Glass fiber insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

I. Inserts and Shields:

1. Application: Piping 1-1/2 inches diameter or larger.

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

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

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

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

J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.

K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet) above finished floor): Finish with canvas jacket sized for finish painting, PVC jacket and fitting covers, aluminum jacket or stainless steel jacket.

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

M. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

N. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum or stainless steel jacket with seams located on bottom side of horizontal piping.

O. Existing insulation damaged by new work shall be repaired and finished to match original new condition.

P. Strainers shall be covered in a manner that will allow the strainer basket to be removed without cutting or destroying insulation.

Q. All portions of insulated piping exposed to the weather, or located in unheated pipe tunnels, shall receive an additional 1 inch thickness of insulation.

R. Insulation at grooved-end pipe couplings and flanged connections shall be full thickness of adjacent pipe insulation. Seal ends of insulation sections to provide continuous vapor barrier.

S. Elastomeric insulation exposed to the weather shall be coated with manufacturer's ultra-violet resistant coating.

3.03 SCHEDULE

A. Cooling Systems:

1. Refrigerant Suction: Elastomeric, 1-1/2 inch thick

2. Refrigerant Hot Gas: Elastomeric, 1/2 inch thick

3. Refrigerant Liquid Exposed to Weather: Elastomeric, 1-1/2 inch thick

B. Other Systems:

1. Piping Exposed to Freezing with Heat Tracing: Additional 1 inch thickness

END OF SECTION 23 0719

SECTION 23 0993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. NOTE: The basis of design supervisory controller for this project is a Johnson Controls FX80 to be located in a NEMA 1 enclosure with a 120/24V transformer and duplex maintenance receptacle. This panel shall be located in the first floor Office 115. Coordinate with owner for exact location.

1.02 SPECIFIC CONTROLS/MECHANICAL CONTRACT REQUIREMENTS

A. Johnson Controls System**:** The building is designed as a basis Johnson Controls System with a series of self-contained controllers with integrated export files. Protocol for all systems shall be BACnet MS/TP. The following "3rd Party" systems shall be integrated into the FX-80 MS/TP trunk through the following equipment requirements by basis manufacturer:

1. Mitsubishi: Provide and install a PAC-YG50ECA expansion controller, M-Net communication cabling, a LAN line to a BAC-HD150 BacNet/M-Net Adapter. Then CAT 6 cabling from the BAC-HD150 to the System FX-80 Ethernet 10/100Mbps port.

2. Johnson Controls (ABCS): Provide and install a FX-80 as noted above. Provide a building wide shielded twisted pair RS-485 interface MS/TP communication truck to all required field controllers and 3rd party devices. This to include all controllers to integrate all new exhaust fans as noted.

3. Daikin Equipment (Rooftop Units): Provide and install a MicroTech III Controller on each rooftop unit that will be programmed to enable/disable all unit operational points. An export file will be provided for point discovery into the FX-80 MS/TP trunk.

4. Trane (Rooftop Units): Provide and install a UC600 Unitary controller in the "Horizon" (RTU-1A) and ReliaTel controller for the "Voyager". Both to be set for RS-485 MS/TP Communications. This to include a preset export file for points as required.

5. Greenheck (Make-Up Air Unit): Provide and install a CAREL microprocessor controller with each unit for MS/TP integration with the FX-80 MS/TP communications Trunk.

B. Complete new building communication cabling in and from Contract areas cabling shall be stranded, shielded and Plenum Rated. Operating Protocol shall be BACnet. Communication for all noted HVAC equipment shall be through a new communication line throughout the school as noted on the contract drawings. Building Supervisory Controller shall be an FX-80 as noted on

Contract Drawings. FX-80 shall be provided with Dual Drivers (BACNET) and dual trunk connections (including an Ethernet RJ45-8P8C connection type). The FX-80 shall be the central system controller and shall be mounted in Office 115.

C. The FX-80 shall integrate an MS/TP Bus around the building to pick up and integrate all third party equipment as required.

D. FX-80 shall be provided with full scheduling, monitoring and trending capabilities (trending of up to 24 points for a 12-month period of time).

E. Contract requirements must provide for 16 hours of system training for FX-80 operations.

F. Contract requirements require all the points listed below under "Display" be sourced and mapped through the server and graphically represented.

G. Provide and install new Temperature Sensors and Current Transducers as noted in sequence requirements below to conform to the operational sequencing.

H. Provide all exhaust fans with unit mounted current transducers for operational proof. ALL fan motors listed in the following sequence shall be newly provided and installed Current Sensor or Transducer to operational proves. This will be transmitted (mapped and sourced) graphically to system unit specific front end.

I. Contract requirements include the complete graphical representation of the building. This to include the identification of all exhaust fans as listed in the sequences below and all other HVAC equipment as noted in the sequence of operations below. This to include a FULL graphical map of the school with individual room units clearly labeled in sub screens with all applicable points as listed below.

J. All equipment defined below will be part of an integrated occupancy schedule that will allow the end user to modify individual or groups of units to an occupied and unoccupied schedule. FX-80 shall also control all setpoints (with individual thermostat occupancy override (1 hour-adjustable) and a 2 degree +/- adjustment at the thermostat. The FX-80 server shall have full override capability on all setpoints and occupancy periods.

K. All units shall be labeled individually on the graphical interface and all indexed references.

L. It is a contract requirement to provide, install and program all required equipment to make the following operational requirements function in an effective, operational and contract compliant manner.

M. New Network Engine (FX-80) shall be web enabled for Ethernet integration. Coordinate with owner on coordination requirements (addressable IP, integration requirements (JAVA) etc.). Owner shall bring connection to JACE 10/100 Mb Ethernet port. Mechanical Contractor to assign/program IP and integrate server to Client Ethernet.

N. The Johnson Controls System shall consist of a series of sensors, field controllers, MS/TP Communications trunk and an FX-80 controller mounted as noted on the contract drawings. This to include Ethernet RJ45 connection between BAC-150HD and FX-80.

O. All noted controllers are a contract requirement. It is the responsibility of the Mechanical Contractor to provide 120/24V control transformers and all required communication and low voltage power wiring to all required equipment. Each "exposed" controller shall be provided with a transformer and NEMA 1 enclosure "Clamshell" and shall be mounted above the ceiling or in storage and janitorial areas near the serviced equipment.

P. The system protocol shall be BacNet.

Q. FX-80 shall reflect a complete building layout and placement of controlled units on an operational interface screen for the owner.

R. Provide and install a Touch Pad interface (EasyIO System View 10" tablet with mounting bracket SH-Systemview 10) and mount on the FX-80 NEMA enclosure. This system shall be provided with a full graphics package. This shall be for owner interface.

S. Provide CHASE Security Systems PTG 653 Thermostat Guard for all zone thermostats/sensors in General Public Access Areas.

T. Provide and install and exterior ambient Temperature/Humidity and integrate into FX-80 both graphically and operationally.

U. NOTE on Contract Control Drawings for any Smoke Dampers, Smoke/Fire Dampers and Fire Dampers. The provision and installation of all three are a requirement of the Mechanical Contractor as noted below:

1. Smoke and Smoke/Fire Dampers: All Dampers shall be Johnson Controls FS-1630 Series dampers with UL/FM approved listed 24 Volt 2 position 350-degree F actuator. It is the responsibility of the controls contractor to provide and install an addressable smoke detector for each smoke damper location as noted on the controls contract drawings. Mechanical Contract requirements shall be as follows:

    a. Provide and install smoke (or smoke/fire) dampers as required.

    b. Provide and install a UL Listed smoke detector with-in 5 feet of the dampers as shown.

    c. Provided detector must be dual pole (contact) such that on contact enables the smoke damper(s) to activate.

d. Power for the smoke detector shall be through the local PCG or EC provided junction 120-volt junction box.

e. EC shall be responsible for providing an addressable relay connection to smoke detector for integration and programing.

f. MC is responsible for the provision, installation and operation of all smoke, smoke fire and fire dampers. This to include all power and communication wiring.

2. Upon activation of the damper the unit controller shall notify the FX-80 which will then in turn note an alarm through the FX-80 and disable the servicing unit. Reset shall be through the FX-80/passcode protected.

3. Fire Dampers: These dampers shall be spring link activated and shall be Johnson Controls FD-1600 series dampers. ATC requirements shall be such that they shall monitor the position of the damper only through the local controller. Upon activation of the damper the PCG shall notify the FX-80 which will ten in turn note an alarm through the owner interface and disable the servicing unit. Reset shall be through the FX-80/passcode protected.

1.03 ROOFTOP UNITS (RTU#1) NORTH WING GUEST (OUTSIDE AIR)

A. Basis of Design Daikin DPS012A. Provide and install a MicroTech III Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a communication interface on the unit mounted MicroTech III as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.

B. RTU-1 shall incorporate low discharge air alarms where if the supply DAT falls below a definable setpoint (initial setting 45) the unit shall disable and an alarm will be sent to the FX-80 for conformation and system reset.

C. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.

D. Sequence of Operations:

1. Occupied/Unoccupied mode. The microprocessor shall index the supply fan on to run continuously at a constant volume while in occupied mode only (There is no unoccupied mode). Occupied temperatures shall be preprogramed directly through the FX-80 to the unit microprocessor. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):

    a. Time:

        1) Occupied: As scheduled
        2) Unoccupied: N/A

    b. System Discharge Temperature (Adjustable through FX-80):

        1) Occupied DAT:

            Cooling: 72 degrees with ambient above or equal to 69 degrees F.
            Heating: 68 degrees with ambient below 69 degrees F.

        2) Unoccupied: N/A.

2. Occupied Mode: The unit shall open outside air damper to minimum position (initial OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The DX coil shall enable in the cooling mode and the hydronic valve shall open full to coil (and then modulate to maintain DAT as noted) to meet setpoints as noted above.

3. Unoccupied Mode: N/A.

4. Warm-up Period: N/A.

5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.

6. Discharge Temperature Maintenance: Utilize DAT mounted in the discharge duct collar sensor to maintain discharge temperature as noted above. If in either the occupied cooling or the heating mode the DAT is satisfied, the fan shall remain running.

7. Low Temperature Protection (Software). The microprocessor shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj).

8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor shall enable when zone temperature rises above set-point and disable when the zone temperature falls to 1 degree below setpoint. Dead band setpoint to be adjustable. Provide reset schedule as follows:

    a. Input Device: Electronic temperature sensor in discharge air

    b. Input Logic: Unit Microprocessor/FX-80 Occupied/Unoccupied setpoints.

    c. Output Device: Microprocessor outputs

9. Heating Demand: Upon call for heating utilize a 1 degree setpoint dead band such that the valve shall open to the coil when the zone temperature falls below setpoint. The valve shall modulate to the coil to maintain a 90-degree discharge. Once space temperature has been satisfied, the PCG shall modulate the valve to maintain 75-degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:

    a. Input Device: Electronic temperature sensor in discharge air.

    b. Input Logic: Unit Microprocessor/FX-80 Occupied/Unoccupied setpoints.

    c. Output Device: Microprocessor outputs.

10. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from Microp. Power to be provided as indicated above. Operation shall be as follows:

    a. Occupied Mode: Minimum position (initial 20% until set by balancer).

    b. Economizer Mode: Maximum position (100% outside air).

    c. Unoccupied Mode: Closed Position (0% outside air).

E. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:

1. DDC system graphic.

2. DDC system on-off indication.

3. DDC system occupied/unoccupied mode.

4. Outdoor-air-temperature indication.

5. Supply-fan on-off indication (command).

6. Supply fan status.

7. Economizer enabled/disabled.

8. Return-fan on-off indication (command).

9. Return fan status.

10. Heating-coil gas-valve position.

11. Heating furnace air-temperature setpoint.

12. Heating Furnace DAT.

13. Cooling-coil air-temperature setpoint.

14. Compressor operational status.

15. Cooling Coil (DX) DAT.

16. Recovery Wheel operational proof.

17. Recovery Wheel Command.

18. Recovery discharge and intake temperature.

19. Smoke Detector Status.

20. Unit Alarm (specific to fault).

F. FX-80 (Writeable) Adjustable Points:

1. Occupied/unoccupied scheduled time periods.

2. Discharge Setpoints (summer/winter).

3. Correlated Ambient setpoints cooling/heating.

4. Unit shutdown/enable.

5. Recovery wheel start stop

6. Alarm reset.

1.04 ROOFTOP UNITS (RTU#1A) SOUTH WING GUEST (OUTSIDE AIR)

A. Basis of Design Trane Horizon. Provide and install a UC600 Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a communication interface on the unit mounted UC600 as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.

B. RTU-1A shall incorporate low discharge air alarms where if the supply DAT falls below a definable setpoint (initial setting 45) the unit shall disable and an alarm will be sent to the FX-80 for conformation and system reset.

C. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.

D. Sequence of Operations:

1. Occupied/Unoccupied mode. The microprocessor shall index the supply fan on to run continuously at a constant volume while in occupied mode only (There is no unoccupied mode). Occupied temperatures shall be preprogramed directly through the FX-80 to the unit UC600. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):

    a. Time:

        1) Occupied: As scheduled.
        2) Unoccupied: Any other time.

b. System Discharge Temperature (Adjustable through FX-80):

1) Occupied DAT:

Cooling: 72 degrees with ambient above or equal to 69 degrees F.
Heating: 68 degrees with ambient below 69 degrees F.

2) Unoccupied: Off.

2. Occupied Mode: The unit shall open outside air damper to minimum position (initial OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The DX coil shall enable in the cooling mode and the hydronic valve shall open full to coil (and then modulate to maintain DAT as noted) to meet setpoints as noted above.

3. Unoccupied Mode: N/A.

4. Warm-up Period: N/A.

5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.

6. Discharge Temperature Maintenance: Utilize DAT mounted in the discharge duct collar sensor to maintain discharge temperature as noted above. If in either the occupied cooling or the heating mode the DAT is satisfied, the fan shall remain running.

7. Low Temperature Protection (Software). The UC600 shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj).

8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor shall enable when zone temperature rises above set-point and disable when the zone temperature falls to 1 degree below setpoint. Dead band setpoint to be adjustable. Provide reset schedule as follows:

a. Input Device: Electronic temperature sensor in discharge air.

b. Input Logic: UC600/FX-80 Occupied/Unoccupied setpoints.

c. Output Device: UC600 outputs.

9. Heating Demand: Upon call for heating utilize a 1 degree setpoint dead band such that the valve shall open to the coil when the zone temperature falls below setpoint. The valve shall modulate to the coil to maintain a 90-degree discharge. Once space temperature has been satisfied, the PCG shall modulate the valve to maintain 75-degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:

    a. Input Device: Electronic temperature sensor in discharge air.

    b . Input Logic: Unit UC600/FX-80 Occupied/Unoccupied setpoints.

    c. Output Device: UC600 outputs.

10. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from Microp. Power to be provided as indicated above. Operation shall be as follows:

    a. Occupied Mode: Minimum position (initial 20% until set by balancer).

    b. Economizer Mode: Maximum position (100% outside air).

    c. Unoccupied Mode: Closed Position (0% outside air).

11. Smoke Condition: If one of the unit smoke detectors goes into alarm, there shall be a contact signal to the UC600, which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80.

E. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:

1. DDC system graphic.

2. DDC system on-off indication.

3. DDC system occupied/unoccupied mode.

4. Outdoor-air-temperature indication.

5. Supply-fan on-off indication (command).

6. Supply fan status.

7. Economizer enabled/disabled.

8. Return-fan on-off indication (command).

9. Return fan status.

10. Heating-coil gas-valve position.

11. Heating furnace air-temperature setpoint.

12. Heating Furnace DAT.

13. Cooling-coil air-temperature setpoint.

14. Compressor operational status.

15. Cooling Coil (DX) DAT.

16. Recovery Wheel operational proof.

17. Recovery Wheel Command.

18. Recovery discharge and intake temperature.

19. Smoke Detector Status.

20. Unit Alarm (specific to fault).

F. FX-80 (Writeable) Adjustable Points:

1. Occupied/unoccupied scheduled time periods.

2. Discharge Setpoints (summer/winter).

3. Correlated Ambient setpoints cooling/heating

4. Unit shutdown/enable.

5. Recovery wheel start stop.

6. Alarm reset.

1.05 ROOFTOP UNIT (RTU#2) BALL ROOM A & B (INCLUDING PREFUNCTION)

A. Basis of Design Daiken MPS035F. Provide and install a MicroTech III Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a

communication interface on the unit mounted MicroTech III as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.

B. Zone Requirements: This unit shall be provided with the following zone sensors. Each of the noted sensors shall be integrated directly into the MicroTech III SA Bus located in the RTU. The Wall Window Sensors controller as noted in "C" below may be integrated directly into the FX-80, which will then be programmed to send a "disable" signal to RTU-2 once the contact is "open".

1. Daikin combo digital temperature and humidity sensor with tenant override and setpoint adjustment mounted in Ball Room A,

2. Daikin combo digital temperature and humidity sensor with tenant override and setpoint adjustment mounted in Ball Room B.

3. Daikin combo digital temperature and humidity sensor with tenant override and setpoint adjustment mounted in mounted in Prefunction/PDR 109.

4. Wall Door sensors as listed in "C" below for each ball room wall window set such that if the wall door is open, the unit will be idle until the door is closed again (contact is closed).

C. Wall Window Sensor: Provide and install a wired Kadtronix HVAC Smart Relay Switch (HSRS) for Ball Room A and B. Integrated the 24V contact directly to the Carel controller such that when the wall window is opened, the corresponding RTU will become idle (shutdown).

D. Unit VFD: The installed VFD is for balancing purposes only and there is no automated duct pressure control required. VFD speed will be integrated into the MicroTech III through analog 0-10vdc output for speed adjustment through FX-80. Feedback for VFD speed required as well (analog input) into the MicroTech III controller.

E. Space (Zone) Sensors Operation: The three zone sensors noted above in three different areas. Each unit shall have a zone occupancy override set for 2 hours (owner adjustable through FX-80 interface). Unit operation for each room shall be "Aggregate Average Demand Override". Such that the RTU shall operate in the heating and cooling mode through an average of the zone temperatures as defined in the sequence below (or as adjusted by the owner through the FX-80 interface). HOWEVER: If in the "heating" mode and one space falls 1 degree below setpoint and "average" temperature of the three zones is satisfied, the microprocessor shall raise the average setpoint one degree to enable the heating function in the unit until the compromising space temperature is with-in setpoint. This function shall occur for a total of a 2 degree increase in setpoint. If the compromising room is still below the low limit setpoint then the FX-80 will indicate an alarm in this area and the system shall remain at the 2 degree increase. The same

function shall occur in the cooling function with the exception that the enable point will be an increase of temperature at 1 degree above setpoint to a maximum of 2 degrees above setpoint.

F. Dehumidification Cycle: If the average zone relative humidity ration rises above 60%, the unit shall enable its "dehumidification" cycle by enable the compressor stage commands for a DX DAT of 52 degrees F and then utilize the unit hot gas reheat to modulate the DAT to 70 deg. F in the heating cycle and 65 deg. F in the cooling cycle. If the zone temperature is satisfied and the average humidity rises above 60% (FX-80 adjustable) the unit shall enable the "dehumidification" cycle and set the DAT to the zone setpoint.

G. Smoke Condition: If one of the unit smoke detectors goes into alarm, there shall be a contact signal to the MT III (MircoTech III), which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.

H. Sequence of Operations:

1. Occupied/Unoccupied mode. The MircoTech III shall index the supply fan on to run continuously at a constant volume while in occupied mode and on temperature requirements in unoccupied mode. Occupied and unoccupied temperatures shall be preprogramed directly through the FX-80 to the unit MircoTech III. There shall be an occupied override switch on the Zone Sensor that will program a (2) hour override into unit for occupancy. There shall also be an Zone Sensor modulation of +/- 2 degrees around programmed setpoint. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):

    a. Time:

        1) Occupied:

            a) As scheduled through FX-80 Schedule Program
            b) Zone Sensor occupied override switch enabled.

        2) Unoccupied: Any other time.

    b. Zone Temperature (Adjustable through FX-80) in "Aggregate Average Demand Override mode as listed above":

1) Occupied:

Cooling: 72 degrees with ambient above or equal to 69 degrees F.
Heating: 68 degrees with ambient below 69 degrees F.

2) Unoccupied:

Cooling: 80 degrees with ambient above or equal to 69 degrees F.
Heating: 60 degrees with ambient below 69 degrees F.

2. Occupied Mode: The unit shall open outside air damper to minimum position (initial 20% OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The evaporator enable in the cooling mode through compressor staging and Compressor #1 speed control and the gas plenum valve shall open full to plenum runners (and then modulate to maintain DAT as noted) to meet setpoints as noted above.

3. Unoccupied Mode: The outside air damper shall remain closed and the return damper shall be full open. The unit shall cycle on temperature maintenance only activating both the compressor staging and modulating the gas furnace to provide a DAT to maintain space temperature. The compressor staging shall enable in the cooling mode and the gas valve/furnace shall open full to coil to meet setpoints as noted above.

4. Warm-up Period: The MircoTech III shall command a warm-up period to begin ½ hour before occupied (as noted above). The fan shall enable with DAT Heating/Cooling control to maintain a DAT until the served space is at setpoint temperature.

5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.

6. Discharge Temperature Maintenance: Utilize DAT sensor to maintain discharge temperature at 90 degrees (Adjustable in the heating cycle). In the cooling mode the MircoTech III shall stage compressors to maintain 55 degrees F. If in either the occupied cooling or the heating mode the space temperature is satisfied, the fan shall remain running. The DAT shall modulate to maintain zone setpoint temperature through compressor staging and gas valve modulation.

7. Low Temperature Protection (Software). The MircoTech III shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj). This safety is in addition to the A70 as noted below.

8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor set shall stage when zone temperature rises above set-point and stage compressors to the "Cooling" DAT of 55 degrees F (adjustable). When the zone temperature falls to .5 degree below setpoint the system shall stage the compressors to maintain the zone setpoint temperature. The fan is always on in the "occupied" mode.

    a. Input Device: MircoTech III through zone sensor average.

    b. Input Device: Electronic temperature sensor in discharge air.

    c. Input Logic: FX-80 Occupied/Unoccupied setpoints.

    d. Output Device: MircoTech III compressor stage control.

    Cooling shall enable when the zone temperature rises above the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously. Unless the space is in the cooling mode and the low temperature protection as noted above.

9. Heating Demand: Upon call for heating utilize a .5 degree setpoint dead band such that the gas valve shall open to the furnace when the zone temperature falls below setpoint. The gas valve shall modulate to the furnace to maintain a 90-degree discharge. Once space temperature has been satisfied, the MircoTech III shall modulate the valve to maintain 75-degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:

    a. Input Device: MircoTech III through zone sensor average.

    b. Input Device: Electronic temperature sensor in discharge air

    c. Input Logic: FX-80 Occupied/Unoccupied setpoints.

    d. Output Device: MircoTech III Analog signal to gas valve actuator.

    Heating shall enable when the zone temperature falls below the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously.

10. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from MircoTech III. Power to be provided as indicated above. Operation shall be as follows:

    a. Occupied Mode: Minimum position (initial 20% until set by balancer).

b. Economizer Mode: Maximum position (100% outside air).

c. Unoccupied Mode: Closed Position (0% outside air).

I. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:

1. DDC system graphic.

2. DDC system on-off indication.

3. DDC system occupied/unoccupied mode.

4. Outdoor-air-temperature indication.

5. Supply-fan on-off indication (command).

6. Supply fan status.

7. Economizer enabled/disabled.

8. Heating-coil gas-valve position.

9. Heating furnace air-temperature setpoint.

10. Heating Furnace DAT.

11. Cooling-coil air-temperature setpoint.

12. Compressor operational/staging status.

13. Dehumidification setpoints.

14. Dehumidification Status.

15. Discharge relative humidity.

16. Return Relative Humidity.

17. Cooling Coil (DX) DAT.

18. VFD Actual Speed (Hertz).

19. Smoke detector status.

20. Damper positions.

21. Unit Alarm (specific to fault).

22. Service Zone Temperatures.

23. Service Zone Humidity.

24. Service Zone "Occupancy" override status.

25. Zone average temperatures and humidity.

J. FX-80 (Writeable) Adjustable Points:

1. Occupied/unoccupied scheduled time periods.

2. Discharge air setpoints (summer/winter).

3. Zone temperature override.

4. Dehumidification control enable setpoints.

5. Unit shutdown/enable.

6. VFD speed.

7. Alarm reset.

8. Unit enable/disable.

9. Return and Outside air damper positions.

10. Economizer enable/disable.

1.06 ROOFTOP UNIT (RTU#3) PENTHOUSE

A. Basis of Design: Daiken MPS015A. Provide and install a MicroTech III Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a communication interface on the unit mounted MicroTech III as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility

of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.

B. Zone Requirements: This unit shall be provided with the following zone sensors. Each of the noted sensors shall be integrated directly into the MicroTech III SA Bus located in the RTU. The Wall Window Sensors controller as noted in "C" below may be integrated directly into the FX-80, which will then be programmed to send a "disable" signal to RTU-2 once the contact is "open".

1. Daikin combo digital temperature and humidity sensor with tenant override and setpoint adjustment mounted in Penthouse (Lounge 402).

C. Wall Window Sensor: Provide and install a wired Kadtronix HVAC Smart Relay Switch (HSRS) for the window wall in the lounge. Utilize two sensors for open detection. Integrated the 24V contact directly to the MicroTech III such that when the wall window is opened, the corresponding RTU will become idle (shutdown).

D. Unit VFD: The installed VFD is for balancing purposes only and there is no automated duct pressure control required. VFD speed will be integrated into the MicroTech III through analog 0-10vdc output for speed adjustment through FX-80. Feedback for VFD speed required as well (analog input) into the MicroTech III controller.

E. Dehumidification Cycle: If the average zone relative humidity ration rises above 60%, the unit shall enable its "dehumidification" cycle by enable the compressor stage commands for a DX DAT of 52 degrees F and then utilize the unit hot gas reheat to modulate the DAT to 70 deg. F in the heating cycle and 65 deg. F in the cooling cycle. If the zone temperature is satisfied and the average humidity rises above 60% (FX-80 adjustable) the unit shall enable the "dehumidification" cycle and set the DAT to the zone setpoint.

F. Smoke Condition: If one of the unit smoke detectors goes into alarm, there shall be a contact signal to the MT III (MircoTech III), which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.

G. Sequence of Operations:

1. Occupied/Unoccupied mode. The MircoTech III shall index the supply fan on to run continuously at a constant volume while in occupied mode and on temperature requirements in unoccupied mode. Occupied and unoccupied temperatures shall be preprogramed directly through the FX-80 to the unit MircoTech III. There shall be an occupied override switch on the Zone Sensor that will program a (2) hour override into unit for occupancy. There shall also be an Zone Sensor modulation of +/- 2 degrees

around programmed setpoint. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):

a. Time:

1) Occupied:

a) As scheduled through FX-80 schedule program.
b) Zone Sensor occupied override switch enabled.

2) Unoccupied: Any other time.

b. Zone Temperature (Adjustable through FX-80):

1) Occupied:

Cooling: 72 degrees with ambient above or equal to 69 degrees F.
Heating: 68 degrees with ambient below 69 degrees F.

2) Unoccupied:

Cooling: 80 degrees with ambient above or equal to 69 degrees F.
Heating: 60 degrees with ambient below 69 degrees F.

2. Occupied Mode: The unit shall open outside air damper to minimum position (initial 20% OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The evaporator enable in the cooling mode through compressor staging and Compressor #1 speed control and the gas plenum valve shall open full to plenum runners (and then modulate to maintain DAT as noted) to meet setpoints as noted above.

3. Unoccupied Mode: The outside air damper shall remain closed and the return damper shall be full open. The unit shall cycle on temperature maintenance only activating both the compressor staging and modulating the gas furnace to provide a DAT to maintain space temperature. The compressor staging shall enable in the cooling mode and the gas valve/furnace shall open full to coil to meet setpoints as noted above.

4. Warm-up Period: The MircoTech III shall command a warm-up period to begin ½ hour before occupied (as noted above). The fan shall enable with DAT Heating/Cooling control to maintain a DAT until the served space is at setpoint temperature.

5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.

6. Discharge Temperature Maintenance: Utilize DAT sensor to maintain discharge temperature at 90 degrees (Adjustable in the heating cycle). In the cooling mode the MircoTech III shall stage compressors to maintain 55 degrees F. If in either the occupied cooling or the heating mode the space temperature is satisfied, the fan shall remain running. The DAT shall modulate to maintain zone setpoint temperature through compressor staging and gas valve modulation.

7. Low Temperature Protection (Software). The MircoTech III shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj). This safety is in addition to the A70 as noted below.

8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor set shall stage when zone temperature rises above set-point and stage compressors to the "Cooling" DAT of 55 degrees F (adjustable). When the zone temperature falls to .5 degree below setpoint the system shall stage the compressors to maintain the zone setpoint temperature. The fan is always on in the "occupied" mode.

    a. Input Device: MircoTech III through zone sensor average.

    b. Input Device: Electronic temperature sensor in discharge air.

    c. Input Logic: FX-80 Occupied/Unoccupied setpoints.

    d. Output Device: MircoTech III compressor stage control.

    Cooling shall enable when the zone temperature rises above the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously. Unless the space is in the cooling mode and the low temperature protection as noted above.

9. Heating Demand: Upon call for heating utilize a .5 degree setpoint dead band such that the gas valve shall open to the furnace when the zone temperature falls below setpoint. The gas valve shall modulate to the furnace to maintain a 90-degree discharge. Once space temperature has been satisfied, the MircoTech III shall modulate the valve to maintain 75-degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:

    a. Input Device: MircoTech III through zone sensor average.

b. Input Device: Electronic temperature sensor in discharge air.

c. Input Logic: FX-80 Occupied/Unoccupied setpoints.

d. Output Device: MircoTech III Analog signal to gas valve actuator.

Heating shall enable when the zone temperature falls below the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously.

10. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from MircoTech III. Power to be provided as indicated above. Operation shall be as follows:

a. Occupied Mode: Minimum position (initial 20% until set by balancer).

b. Economizer Mode: Maximum position (100% outside air).
c. Unoccupied Mode: Closed Position (0% outside air).

H. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:

1. DDC system graphic.

2. DDC system on-off indication.

3. DDC system occupied/unoccupied mode.

4. Outdoor-air-temperature indication.

5. Supply-fan on-off indication (command).

6. Supply fan status.

7. Economizer enabled/disabled.

8. Heating-coil gas-valve position.

9. Heating furnace air-temperature setpoint.

10. Heating Furnace DAT.

11. Cooling-coil air-temperature setpoint.

12. Compressor operational/staging status.

13. Dehumidification setpoints.

14. Dehumidification status.

15. Discharge relative humidity.

16. Return air relative humidity.

17. Cooling Coil (DX) DAT.

18. VFD Actual Speed (Hertz).

19. Smoke Detector Status.

20. Damper positions (Return/Outside air).

21. Unit Alarm (specific to fault).

22. Service Zone Temperature.

23. Service Zone Humidity.

24. Service Zone "Occupancy" override status.

25. Zone average temperatures and humidity.

I. FX-80 (Writeable) Adjustable Points:

1. Occupied/unoccupied scheduled time periods.

2. Discharge Setpoints (summer/winter).

3. Zone temperature override.

4. Dehumidification Control enable setpoints.

5. Unit shutdown/enable.

6. VFD Speed.

7. Alarm reset.

8. Unit enable/disable.

9. Economizer enable/disable.

1.07 ROOFTOP UNIT (RTU#4) RIVERSIDE DINNING AND FLEX SPACE

A. Basis of Design TraneYCH420 "Voyager". Provide and install a Trane UC600 to communicate with the unit mounted ReliaTel Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a communication interface on the unit mounted ReliaTel as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.

B. NOTE: The UC600 is required due to the SA bus requirements and the control requirements as listed below. Power for the UC600 shall be as part of the package as provided by Trane and installed in the factory. Note that the UC600 can be mounted below in the space with approval from the engineer and owner.

C. Zone Requirements: This unit shall be provided with the following zone sensors. Each of the noted sensors shall be integrated directly into the ReliaTel SA Bus located in the RTU. The Wall Window Sensors controller as noted in "C" below may be integrated directly into the FX-80, which will then be programmed to send a "disable" signal to RTU-2 once the contact is "open".

1. Trane BAYSENS071A digital temperature sensor with tenant override and setpoint adjustment mounted in Riverside Dinning 125.

2. Trane BAYSENS071A digital temperature sensor with tenant override and setpoint adjustment mounted in Riverside Dining 121.

3. Trane BAYSENS071A digital temperature sensor with tenant override and setpoint adjustment mounted in mounted in Flex Space 125.

4. Wall Door sensors as listed in "C" below for each ball room wall window set such that if the wall door is open, the unit will be idle until the door is closed again (contact is closed).

5. Return Air Humidity Sensor.

D. Wall Window Sensor: Provide and install a wired Kadtronix HVAC Smart Relay Switch (HSRS) for both Riverside Dining Rooms. Integrated the 24V contact directly to the UC600 controller such that when the wall window is opened, the corresponding RTU will become idle (shutdown).

E. Unit VFD: This unit is a single zone VAV (Variable Air Volume) unit. Operation shall continuous air flow with no VAV single zone operation. The installed VFD is for balancing purposes only and there is no automated duct pressure control required. VFD speed will be integrated into the UC600 through analog 0-10vdc output for speed adjustment through FX-80. Feedback for VFD speed required as well (analog input) into the UC600 controller.

F. Space (Zone) Sensors Operation: The three zone sensors noted above in three different areas. Each unit shall have a zone occupancy override set for 2 hours (owner adjustable through FX-80 interface). Unit operation for each room shall be "Aggregate Average Demand Override". Such that the RTU shall operate in the heating and cooling mode through an average of the zone temperatures as defined in the sequence below (or as adjusted by the owner through the FX-80 interface). HOWEVER: If in the "heating" mode and one space falls 1 degree below setpoint and "average" temperature of the three zones is satisfied, the microprocessor shall raise the average setpoint 1 degree to enable the heating function in the unit until the compromising space temperature is with-in setpoint. This function shall occur for a total of a 2 degree increase in setpoint. If the compromising room is still below the low limit setpoint then the FX-80 will indicate an alarm in this area and the system shall remain at the 2 degree increase. The same function shall occur in the cooling function with the exception that the enable point will be an increase of temperature at 1 degree above setpoint to a maximum of 2 degrees above setpoint.

G. Dehumidification Cycle: If the return air relative humidity ration rises above 60%, the unit shall enable its "dehumidification" cycle by enable the compressor stage commands for a DX DAT of 52 degrees F and then utilize the unit hot gas reheat to modulate the DAT to 70 deg. F in the heating cycle and 65 deg. F in the cooling cycle. If the zone temperature is satisfied and the average humidity rises above 60% (FX-80 adjustable) the unit shall enable the "dehumidification" cycle and set the DAT to the zone setpoint.

H. Smoke Condition: If one of the unit smoke detectors goes into alarm, there shall be a contact signal to the UC600, which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.

I. Sequence of Operations:

1. Occupied/Unoccupied mode. The UC600 shall index the supply fan on to run continuously at a constant volume while in occupied mode and on temperature requirements in unoccupied mode. Occupied and unoccupied temperatures shall be preprogramed directly through the FX-80 to the unit UC600. There shall be an occupied

override switch on the Zone Sensor that will program a 2 hour override into unit for occupancy. There shall also be a Zone Sensor modulation of +/- 2 degrees around programmed setpoint. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):

a. Time:

1) Occupied:

a) As scheduled through FX-80 Schedule Program.
b) Zone Sensor occupied override switch enabled.

2) Unoccupied: Any other time.

b. Zone Temperature (Adjustable through FX-80) in "Aggregate Average Demand Override mode as listed above":

1) Occupied:

Cooling: 72 degrees with ambient above or equal to 69 degrees F.
Heating: 68 degrees with ambient below 69 degrees F.

2) Unoccupied:

Cooling: 80 degrees with ambient above or equal to 69 degrees F.
Heating: 60 degrees with ambient below 69 degrees F.

2. Occupied Mode: The unit shall open outside air damper to minimum position (initial 20% OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The evaporator enable in the cooling mode through compressor staging and Compressor #1 speed control and the gas plenum valve shall open full to plenum runners (and then modulate to maintain DAT as noted) to meet setpoints as noted above.

3. Unoccupied Mode: The outside air damper shall remain closed and the return damper shall be full open. The unit shall cycle on temperature maintenance only activating both the compressor staging and modulating the gas furnace to provide a DAT to maintain space temperature. The compressor staging shall enable in the cooling mode and the gas valve/furnace shall open full to coil to meet setpoints as noted above.

4. Warm-up Period: The UC600 shall command a warm-up period to begin ½ hour before occupied (as noted above). The fan shall enable with DAT Heating/Cooling control to maintain a DAT until the served space is at setpoint temperature.

5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.

6. Discharge Temperature Maintenance: Utilize DAT sensor to maintain discharge temperature at 90 degrees (Adjustable in the heating cycle). In the cooling mode the UC600 shall stage compressors to maintain 55 degrees F. If in either the occupied cooling or the heating mode the space temperature is satisfied, the fan shall remain running. The DAT shall modulate to maintain zone setpoint temperature through compressor staging and gas valve modulation.

7. Low Temperature Protection (Software). The UC600 shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj). This safety is in addition to the A70 as noted below.

8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor set shall stage when zone temperature rises above set-point and stage compressors to the "Cooling" DAT of 55 degrees F (adjustable). When the zone temperature falls to .5 degree below setpoint the system shall stage the compressors to maintain the zone setpoint temperature. The fan is always on in the "occupied" mode.

    a. Input Device: ReliaTel/UC600 through zone sensor average.

    b. Input Device: Electronic temperature sensor in discharge air.

    c. Input Logic: FX-80 Occupied/Unoccupied setpoints.

    d. Output Device: Relaitel compressor stage control.

    Cooling shall enable when the zone temperature rises above the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously. Unless the space is in the cooling mode and the low temperature protection as noted above.

9. Heating Demand: Upon call for heating utilize a .5 degree setpoint dead band such that the gas valve shall open to the furnace when the zone temperature falls below setpoint. The gas valve shall modulate to the furnace to maintain a 90-degree discharge. Once space temperature has been satisfied, the Reliatel shall modulate the valve to maintain 75-

degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:

a. Input Device: UC600 through zone sensor average.

b. Input Device: Electronic temperature sensor in discharge air.

c. Input Logic: FX-80 Occupied/Unoccupied setpoints.

d. Output Device: UC600 Analog signal to gas valve actuator.

Heating shall enable when the zone temperature falls below the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously.

10. Outside Air Damper: The damper shall operate through three positions (Binary signals) from MircoTech III. Power to be provided as indicated above. Operation shall be as follows:

a. Occupied Mode: Minimum position (initial 20% until set by balancer).

b. Economizer Mode: Maximum position (100% outside air).

c. Unoccupied Mode: Closed Position (0% outside air).

J. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:

1. DDC system graphic.

2. DDC system on-off indication.

3. DDC system occupied/unoccupied mode.

4. Outdoor-air-temperature indication.

5. Supply-fan on-off indication (command).

6. Supply fan status.

7. Economizer enabled/disabled.

8. Heating-coil gas-valve position.

9. Heating furnace air-temperature setpoint.

10. Heating Furnace DAT.

11. Cooling-coil air-temperature setpoint.

12. Compressor operational/staging status.

13. Dehumidification setpoints.

14. Dehumidification Status.

15. Discharge relative humidity.

16. Return Relative Humidity.

17. Cooling Coil (DX) DAT.

18. VFD Actual Speed (Hertz).

19. Smoke detector status.

20. Damper positions.

21. Unit Alarm (specific to fault).

22. Service Zone Temperatures.

23. Return Air Humidity.

24. Service Zone "Occupancy" override status.

25. Zone average temperatures and humidity.

K. FX-80 (Writeable) Adjustable Points:

1. Occupied/unoccupied scheduled time periods.

2. Discharge air setpoints (summer/winter).

3. Zone temperature override.

4. Dehumidification control enable setpoints.

5. Unit shutdown/enable.

6. VFD speed.

7. Alarm reset.

8. Unit enable/disable.

9. Return and Outside air damper positions.

10. Economizer enable/disable.

1.08 MAU (Make-Up Air Units)

A. There are a series of three Make-Up Air Units on this project: the following is by MAU#:

1. MAU#1: Basis of Design: Greenheck IGX-112-H22.

2. MAU#2: Basis of Design: Greenheck IGX-109-H12.

3. MAU#3: Basis of Design: Greenheck IGX-109-H12.

B. NOTE: The required VFD for these unit MUST be provided and installed by the ATC Contractor. Refer to Contract Drawing M-7 for requirements. VFD must integrate with the control center as listed below and be listed for the horsepower and fan on equipment. Controls to be provided with equipment:

1. CAREL Microprocessor (MicroTech III).

2. DAT Sensor.

3. pCOe Expansion Board (furnace interface).

4. Furnace controller.

5. Ignition Controller.

6. 120/24V Control Transformer.

7. All sensors and control wiring.

8. Smoke Detector.

C. The Controls Contractor will be responsible to provide and install the following:

1. Provide all control and 24V wiring to all control sensors and actuators associated with all control parts as listed above.

2. Provide and install a Discharge Air Temperature Sensor at the unit discharge.

D. Provide integrated smoke shutdown with provided smoke detector. Install smoke detector as per manufacturer's instructions and attain addressable relay from Fire Alarm Contractor. Wire and program shutdown into CAREL controller.

E. Communications from Captive Air Hood Controller Requirements:

1. Provide communication connection to microprocessor from Captive Air Hood connection for the following:

a. Enable/disable.

b. Supply fan speed (4 to 20ma) or (0 to 10Vdc).

c. Operational Prove (if required).

d. Emergency Stop.

F. Smoke Condition: If the unit smoke detector goes into alarm, there shall be a contact signal to the MicroTech III, which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80. The MAU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC

G. Sequence of Operations:

1. "Enable" mode. The Unit Master Controller upon enable signal from the Captive Air Hood Controller shall open the outside air damper and index the fan to a preset VFD speed. The VFD speed shall then reset to conform to a signal (4 to 20ma) from the Captive Air Hood Controller. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):

a. Time:

1) Enable:

a) As commanded through Hood Controller.
b) FX-80 override control.

2) Unoccupied: N/A.

b. DAT (Adjustable through FX-80):

1) Enable: The MicroTech III shall enable and modulate the gas furnace (valve) to maintain a 68 to 72 degree F DAT. DAT shall be monitored through the unit discharge air temperature sensor.

2. Enable Mode: The unit shall open outside air damper to full position (100% OA), The unit supply fan shall enable to a present speed as noted above fan shall enable (to minimum position). The furnace shall modulate to maintain a DAT as noted above.

3. Unoccupied Mode: N/A.

4. Warm-up Period: N/A.

5. Economizer Cycle: N/A.

6. Discharge Temperature Maintenance: Utilize DAT sensor to maintain discharge temperature at 72 degrees (Adjustable in the heating cycle). If the DAT falls below 50 degrees F in the heating mode (exterior ambient less than 40 degrees F) a notifying alarm will be sent through to the FX-80.

7. Disable Mode: If a signal is sent from the Hood Controller (either Ansul Discharge or System Off) to disable, the unit will shut down (damper closed, furnace off and fan disabled) and send an alarm through to the FX-80.

8. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from the MicroTech III. Power to be provided as indicated above. Operation shall be as follows:

a. Enable Mode: Maximum position (100% outside air).

b. Disable Mode: Closed Position (0% outside air).

9. FX-80 Graphical Interface shall be as follows:

a. DDC system graphic.

b. DDC system on-off indication.

c. DDC system occupied/unoccupied mode.

d. Outdoor-air-temperature indication.

e. Supply-fan on-off indication.

f. Supply Fan Command Speed (from hood controller).

g. Fan-discharge air-temperature setpoint heating.

h. Actual Fan speed (Hz-from VFD Feedback).

i. Heating-furnace-valve position.

j. Discharge Air Temperature.

k. Smoke Detector Status.

l. Unit Alarm (command fault).

m. Unit Supply Fan Prove (VFD Feedback).

10. FX-80 Adjustable Points:

a. System Enable/Disable.

b. DAT Setpoints.

c. Alarm Reset.

d. VFD speed command.

1.09 AIR SOURCE HEAT PUMPS

A. This project has a series of Mitsubishi Heat Pumps as noted on Contract Drawing M-7. The communication system shall be a Mitsubishi proprietary system called M-NET. This "Communication" system shall be required to have a building wide communications trunk separate from that of the JCI MS/TP trunk noted above. The new "M-Net" communications trunk shall be separate and connect to the controller as listed in Paragraph 1.02 above. Note the following:

B. Controller: Each heat pump will be provided with a PAR-32MAA Zone Controller. To be mounted in each noted space for individual heat pump control.

C. Control Requirements:

1. Wall mounted NS Sensor to be as noted (MA). Provide and install MJ back to Heat Pump.

2. This unit WILL sit on the communications trunk and be integrated back to the M-Net BACNet Integrator.

D. Sequence of Operations:

1. Occupied/Unoccupied mode. There shall be an occupied override switch on the MA that shall index the supply fan on to run continuously at a "occupied" setpoint. Initial Settings (to be modified upon owner's request and adjustable through FX-80 BacNet interface):
   a. Zone Temperature:

      1) Occupied:

         Cooling: 72 degrees with ambient above or equal to 69 degrees F.
         Heating: 68 degrees with ambient below 69 degrees F.

      2) Unoccupied:

         Cooling: 80 degrees with ambient above or equal to 69 degrees F.
         Heating: 60 degrees with ambient below 69 degrees F.

2. Occupied Mode: The heat pump shall have the fan continuously operate to assure outside air is supplied to the zone. The heat pump shall heat and cool through temperature as sensed by the zone MA for temperature settings as noted in the "Occupied" time as noted above.

3. Unoccupied Mode: The fan shall only operate in the cooling and heating mode to maintain the "unoccupied" space temperature. If the space temperature is satisfied to the "unoccupied" setpoints

4. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the system shall enable when zone temperature rises above set-point and disable when the zone temperature falls to .5 degree below setpoint. Dead band setpoint to be adjustable.

5. Heating Demand: Upon call for heating utilize a .5 degree setpoint dead band such that the system shall enable when zone temperature falls below set-point and disable when the zone temperature rises to .5 degree above setpoint. Dead band setpoint to be adjustable. There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously.

6. FX-80 Graphical Interface shall be as follows:

   a. DDC system graphic.

   b. DDC system on-off indication.

   c. DDC system occupied/unoccupied mode.

   d. Outdoor-air-temperature indication.

   e. Supply-fan on-off indication.

   f. Heating Mode.

   g. Cooling Mode.

   h. Zone temperature indication.

   i. Zone temperature setpoint.

   j. Unit Alarm (command fault-CT,DAT).

7. FX-80 Adjustable Points:

   a. Occupied/unoccupied scheduled time periods.

   b. Occupied/Unoccupied Setpoints.

   c. System Enable/Disable.

1.10 EXHAUST FAN CONTROL

A. Refer to Contract Drawing M-7. There are nine exhaust fans on this project and they shall be controlled as follows:

B. Exhaust Fan #1: This fan operates in conjunction with Kitchen Hood #52. This fan must be provided and installed with a GreenHeck "Vari-Green" VGD-100+ controller. This shall accept a signal from the Captive Air Hood Controller (0 to 10VDC) or (4 to 20ma). There also will be an enable and disable signal.

C. Exhaust Fan #2: This fan operates in conjunction with Kitchen Hood #90. This fan must be provided and installed with a GreenHeck "Vari-Green" VGD-100+ controller. This shall accept a signal from the Captive Air Hood Controller (0 to 10VDC) or (4 to 20ma). There also will be an enable and disable signal.

D. Exhaust Fan #3: This fan operates in conjunction with the dishwasher hood. Provide a "relay "switch" on the side of the hood for operation. Utilize a current switch for operational proof.

E. Exhaust Fan #4: This fan operates toilet exhaust and shall be programmed through a relay to enable and disable on "occupancy" through a relay. Utilize a current switch for operational proof.

F. Exhaust Fan #5: This fan operates in conjunction with Kitchen Hood #122. This fan must be provided and installed with a GreenHeck "Vari-Green" VGD-100+ controller. This shall except a signal from the Captive Air Hood Controller (0 to 10VDC) or (4 to 20ma). There also will be an enable and disable signal.

G. Exhaust Fan #6: This fan operates in conjunction with combustion relief for MAU-1 and MAU-2. This fan must be provided and installed with a GreenHeck "Vari-Green" VGD-100+ controller. This shall accept a signal from each individual MAU to enable to a balanced setpoint. The fan shall enable to individual setpoints as per their operational status.

H. Exhaust Fan #7: This fan operates toilet exhaust and shall be programmed through a relay to enable and disable on "occupancy" through a relay. Utilize a current switch for operational proof.

I. Exhaust Fans EF-8 and EF-9 shall be self-contained with 24V thermostats mounted in the noted served rooms. There is no ATC interface.

J. FX-80 Graphical Interface shall be as follows:

1. DDC system graphic.

2. DDC system on-off indication.

3. DDC system occupied/unoccupied mode.

4. Fan command.

5. Fan Speed (on Vari-Green Units).

6. Fan command status.

7. Fan operational proof (CT).

8. Unit Alarm (failure to adhere to a command).

K. FX-80 Adjustable Points:

1. Occupied/Unoccupied Setpoints.

2. Unit Shutdown.

3. Supply Fan Enable/Disable.

4. Supply Fan Speed (on Vari-Green Units).

L. Cabinet Unit Heaters and Electric Unit Heaters:

1. These units shall be self-contained with no ATC interface.

END OF SECTION 23 0993

SECTION 23 2300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Check valves.

G. Pressure relief valves.

H. Filter-driers.

I. Solenoid valves.

J. Expansion valves.

K. Receivers.

L. Flexible connections.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ARI 495 - Refrigerant Liquid Receivers; Air-Conditioning and Refrigeration Institute.

B. ARI 710 - Performance Rating of Liquid-Line Dryers; Air-Conditioning and Refrigeration Institute.

C. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Driers; Air-Conditioning and Refrigeration Institute.

D. ARI 750 - Thermostatic Refrigerant Expansion Valves; Air-Conditioning and Refrigeration Institute.

E. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants; Air-Conditioning and Refrigeration Institute.

F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

H. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers.

I. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers.

J. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers.

K. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes; The American Society of Mechanical Engineers.

L. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers.

M. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; (ANSI/ASME B31.9).

N. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

O. ASTM A 234/A 234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

P. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.

Q. ASTM B 88M - Standard Specification for Seamless Copper Water Tube (Metric).

R. ASTM B 280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

S. ASTM F 708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

T. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society.

U. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.

V. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

W. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

X. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

Y. UL 429 - Electrically Operated Valves; Underwriters Laboratories Inc.

1.04 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASME B31.5 or MSS SP-69, unless indicated otherwise.

C. Liquid Indicators:

1. Use line size liquid indicators in main liquid line leaving condenser.

2. If receiver is provided, install in liquid line leaving receiver.

3. Use line size on leaving side of liquid solenoid valves.

D. Valves:

1. Use service valves on suction and discharge of compressors.

2. Use gage taps at compressor inlet and outlet.

3. Use gage taps at hot gas bypass regulators, inlet and outlet.

4. Use check valves on compressor discharge.

5. Use check valves on condenser liquid lines on multiple condenser systems.

E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Strainers:

1. Use line size strainer upstream of each automatic valve.

2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.

3. On steel piping systems, use strainer in suction line.

4. Use shut-off valve on each side of strainer.

G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.

H. Filter-Driers:

1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

2. Use a filter-drier on suction line just ahead of compressor.

3. Use sealed filter-driers in lines smaller than 3/4 inch outside diameter.

4. Use sealed filter-driers in low temperature systems.

5. Use sealed filter-driers in systems utilizing hermetic compressors.

6. Use replaceable core filter-driers in lines of 3/4 inch outside diameter or greater.

7. Use replaceable core liquid-line filter-driers in systems utilizing receivers.

8. Use filter-driers for each solenoid valve.

I. Solenoid Valves:

1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.

2. Use in liquid line of single or multiple evaporator systems.

3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

J. Receivers:

1. Sized to accommodate pump down charge.

2. Use on systems with long piping runs.

K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.05 SUBMITTALS

A. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

C. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Indicate results of leak test, acid test.

E. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

F. Submit welders certification of compliance with ASME (BPV IX) or AWS D1.1.

G. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

H. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.06 QUALITY ASSURANCE

A. Installer: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

B. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.

C. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Welders Certification: In accordance with ASME (BPV IX) or AWS D1.1.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.09 MAINTENANCE PRODUCTS

A. Provide two refrigeration oil test kits each containing everything required to conduct one test.

B. Provide two filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.01 PIPING

A. Copper Tube: ASTM B 280, H58 hard drawn.

1. Fittings: ASME B16.22 wrought copper.

2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.

B. Copper Tube to 7/8 inch OD: ASTM B 88 (ASTM B 88M), Type K (A), annealed.

1. Fittings: ASME B16.26 cast copper.

2. Joints: Flared.

C. Steel Pipe: ASTM A 53/A 53M, Schedule 40, black.

1. Fittings: ASTM A 234/A 234M, wrought steel welding type.

2. Joints: Welded in accordance with AWS D1.1.

D. Steel Pipe Sizes 12 Inch and Over: ASTM A 53/A 53M, 0.375 inch wall, black.

1. Fittings: ASTM A 234/A 234M, wrought steel welding type.

2. Joints: Welded in accordance with AWS D1.1.

E. Pipe Supports and Anchors:

1. Conform to ASME B31.5, ASTM F708, MSS SP-58, MSS SP-69 and MSS SP-89.

2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.

3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.

7. Vertical Support: Steel riser clamp.

8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

10. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

11. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.02 REFRIGERANT

A. Refrigerant: As scheduled on the drawings and as defined in ASHRAE Std. 34.

2.03 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:

1. Henry Technologies

2. Parker Hannifin/Refrigeration and Air Conditioning

3. Sporlan Valve Company

B. Indicators: Single or double port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.04 VALVES

A. Manufacturers:

1. Hansen Technologies Corporation

2. Henry Technologies

3. Danfoss Automatic Controls

B. Diaphragm Packless Valves:

1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

C. Packed Angle Valves:

1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

D. Ball Valves:

1. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

E. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

F. Valve body material shall be compatible with the piping in which it is installed.

2.05 STRAINERS

A. Straight Line or Angle Line Type:

1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

B. Straight Line, Non-Cleanable Type:

1. Steel shell, copper plated fittings, stainless steel wire screen.

2.06 CHECK VALVES

A. Manufacturers:

1. Hansen Technologies Corporation

2. Parker Hannifin/Refrigeration and Air Conditioning

3. Sporlan Valve Company

B. Globe Type:

1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 425 psi.

C. Straight Through Type:

1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.07 PRESSURE REGULATORS

A. Manufacturers:

1. Hansen Technologies Corporation

2. Parker Hannifin/Refrigeration and Air Conditioning

3. Sporlan Valve Company

B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.

2.08 PRESSURE RELIEF VALVES

A. Manufacturers:

1. Hansen Technologies Corporation

2. Henry Technologies

3. Sherwood Valve/Harsco Corporation

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 450 psi.

2.09 FILTER-DRIERS

A. Manufacturers:

1. Flow Controls Division of Emerson Electric

2. Parker Hannifin/Refrigeration and Air Conditioning

3. Sporlan Valve Company

4. Substitutions: See Section 01 6000 - Product Requirements.

B. Performance: In accordance with ARI 710.

C. Cores: Molded molecular sieve desiccant compatible with refrigerant, activated alumina, and filtration to 40 microns; of construction that will not pass into refrigerant lines.

D. Construction: UL listed.

1. Replaceable Core Type: Steel shell with removable cap.

2. Sealed Type: Copper or steel shell.

3. Connections: As specified for applicable pipe type.

2.10 SOLENOID VALVES

A. Manufacturers:

1. Flow Controls Division of Emerson Electric

2. Parker Hannifin/Refrigeration and Air Conditioning

3. Sporlan Valve Company

4. ASCO

B. Valve: ARI 760, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), with flared, solder, or threaded ends; for maximum working pressure of 500 psi.

C. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box.

D. Electrical Characteristics: As noted on the drawings.

2.11 EXPANSION VALVES

A. Manufacturers:

1. Flow Controls Division of Emerson Electric

2. Parker Hannifin/Refrigeration and Air Conditioning

3. Sporlan Valve Company

B. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole or mechanical pressure limit (maximum operating pressure MOP feature), adjustable superheat setting, replaceable inlet strainer, with non-replaceable or replaceable capillary tube and remote sensing bulb and remote bulb well.

C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.12 ELECTRONIC EXPANSION VALVES

A. Manufacturers:

1. Danfoss Automatic Controls

2. Parker Hannifin/Refrigeration and Air Conditioning

3. Sporlan Valve Company

B. Valve:

1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.

C. Evaporation Control System:

1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.13 RECEIVERS

A. Manufacturers:

1. Henry Technologies

2. Parker Hannifin/Refrigeration and Air Conditioning

3. Sherwood Valve/Harsco Corporation

B. Internal Diameter 6 inch and Smaller:

1. ARI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

C. Internal Diameter Over 6 inch:

1. ARI 495, welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve.

2.14 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Circuit Hydraulics, Ltd.

2. Flexicraft Industries

3. Penflex

B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Inserts:

1. Provide inserts for placement in concrete formwork.

2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above, flush with top of, or recessed into and grouted flush with slab.

G. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.5, ASTM F708, and MSS SP-89.

2. Support horizontal piping as scheduled.

3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

4. Place hangers within 12 inches of each horizontal elbow.

5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

7. Provide copper plated hangers and supports for copper piping.

H. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Provide clearance for installation of insulation and access to valves and fittings.

J. Provide access to concealed valves and fittings. Coordinate size and location of access doors.

K. Flood piping system with nitrogen when brazing.

L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

M. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting.

N. Insulate piping and equipment.

O. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

P. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass in liquid line.

Q. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

R. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

S. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

T. Fully charge completed system with refrigerant after testing.

U. Provide electrical connection to solenoid valves.

3.03 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using electronic leak detector. Test to no leakage.

3.04 HANGER SCHEDULE

A. Hanger Spacing for Steel Pipe:

1. 1 inch and smaller, 6 feet maximum span, 3/8 inch minimum rod size.

2. 1-1/4 inch to 2 inches, 9 feet maximum span, 3/8 inch minimum rod size.

3. 2-1/2 inches to 5 inches, 10 feet maximum span, 1/2 inch minimum rod size.

4. 6 inches and larger, 12 feet maximum span, 5/8 inch minimum rod size.

B. Hanger Spacing for Copper Tubing:

1. 1 inch and smaller, 6 feet maximum span, 3/8 inch minimum rod size.

2. 1-1.4 inch and larger, 10 feet maximum span, 1/2 inch minimum rod size.

END OF SECTION 23 2300

SECTION 23 3100 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Metal ductwork.

B. Casing and plenums.

C. Kitchen hood ductwork.

D. Duct cleaning.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.

B. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

D. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened.

E. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

F. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

G. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

H. ASTM C 14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.

I. ASTM C 14M - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).

J. ASTM C 443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

K. ASTM C 443M - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric).

L. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association.

M. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association.

N. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association.

O. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association.

P. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.

Q. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.

1.04 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.05 SUBMITTALS

A. Product Data: Provide data for duct materials, duct liner, and duct connections.

B. Shop Drawings shall:

1. Be 3/8-inch scale and shall indicate all ceiling obstructions, including, but not limited to, sprinkler heads, ceiling inserts, lighting fixtures, and other ceiling or slab mounted devices that could interfere with the installation of the work.

2. Show fabrication, assembly and installation, including plans, elevations, sections, components and attachments to other work.

3. Show factory and shop fabricated ducts and fittings.

4. Include duct layout indicating sizes, configuration, liner material, and static pressure classes.

5. Indicate elevation of top of ducts.

6. Indicate dimensions of main duct runs from building grid lines.

7. Indicate fittings.

8. Indicate reinforcement and spacing.

9. Show seam and join construction.

10. Show penetrations through fire-rated and other partitions.

11. Show equipment installation based on equipment being used on project.

12. Indicate locations for duct accessories, including dampers, turning vanes, and access doors and panels.

13. Indicate hangers and supports, including methods for duct and building attachment, and vibration isolation.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with generator construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components.

3. Structural members to which duct will be attached.

4. Size and location of initial access modules for acoustical tile.

5. Penetrations of smoke barriers and fire-rated construction.

6. Items penetrating finished ceiling, including, but not limited to, the following:

a. Lighting fixtures

b. Air outlets and inlets

c. Sprinkler

d. Access panels

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

E. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.

F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience.

1.07 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A and NFPA 90B and NFPA 96 standards.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS Type B, with G90/Z275 coating.

B. Steel Ducts: ASTM A 1008/A 1008M, Designation CS, cold-rolled commercial steel, or ASTM A 1011/A 1011M, Designation CS, hot-rolled steel.

C. Aluminum Ducts: ASTM B 209 (ASTM B 209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

D. Flexible Ducts:

1. Manufacturers:

a. Flexmaster USA

2. Two ply vinyl film supported by helically wound spring steel wire.

    a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.

b. Maximum Velocity: 4000 fpm.

c. Temperature Range: -10 degrees F to 160 degrees F.

3. UL Labeled, black polymer film supported by helically wound spring steel wire.

    a. Pressure Rating: 4 inches WG positive and 0.5 inches WG negative.

    b. Maximum Velocity: 4000 fpm.

    c. Temperature Range: -20 degrees F to 175 degrees F.

4. UL labeled, multiple layers of aluminum laminate supported by helically wound spring steel wire.

    a. Pressure Rating: 10 inches WG positive and 1.0 inches negative.

    b. Maximum Velocity: 4000 fpm.

    c. Temperature Range: -20 degrees F to 210 degrees F.

5. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.

    a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.

    b. Maximum Velocity: 4000 fpm.

    c. Temperature Range: -20 degrees F to 210 degrees F.

6. UL 181, Class 0, interlocking spiral of aluminum foil.

    a. Pressure Rating: 8 inches WG positive or negative.

    b. Maximum Velocity: 5000 fpm.

    c. Temperature Range: -100 degrees F to 435 degrees F.

E. Insulated Flexible Ducts:

1. Manufacturers:

a. Flexmaster USA

2. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene or aluminized vapor barrier film.

   a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.

   b. Maximum Velocity: 4000 fpm.

   c. Temperature Range: -10 degrees F to 160 degrees F.

3. Black polymer film supported by helically wound spring steel wire; fiberglass insulation; polyethylene or aluminized vapor barrier film.

   a. Pressure Rating: 4 inches WG positive and 0.5 inches WG negative.

   b. Maximum Velocity: 4000 fpm.

   c. Temperature Range: -20 degrees F to 175 degrees F.

4. Multiple layers of aluminum laminate supported by helically wound spring steel wire; fiberglass insulation; polyethylene or aluminized vapor barrier film.

   a. Pressure Rating: 10 inches WG positive and 1.0 inches negative.

   b. Maximum Velocity: 4000 fpm.

   c. Temperature Range: -20 degrees F to 210 degrees F.

5. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire; fiberglass insulation; polyethylene or aluminized vapor barrier film.

   a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.

   b. Maximum Velocity: 4000 fpm.

   c. Temperature Range: -20 degrees F to 210 degrees F.

6. UL 181, Class 0, interlocking spiral of aluminum foil; fiberglass insulation; polyethylene or aluminized vapor barrier film.

   a. Pressure Rating: 8 inches WG positive or negative.

   b. Maximum Velocity: 5000 fpm.

c. Temperature Range: -20 degrees F to 250 degrees F.

F. Stainless Steel Ducts: ASTM A 666, Type 304 for dishwasher exhaust, sterilizers, cart washers, and the like, or Type 316 for laboratory fume hood exhausts.

G. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.

2. VOC Content: Not more than 250 g/L, excluding water.

3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.

4. For Use With Flexible Ducts: UL labeled.

5. Acceptable Manufacturers:

a. Foster Products

b. Durodyne

H. Hanger Rod: ASTM A 36/A 36M; steel; threaded both ends, threaded one end, or continuously threaded.

I. Hanger Cable: Braided steel aircraft cable, C-type beam clamp with set screw and adjustable locking clamp. Ductmate Clutcher, or equal.

2.02 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

D. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

E. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

G. Fittings shall be of same material and thickness as the duct.

H. Remove stick-on labels from exposed ductwork. Prime exposed ductwork for finish painting.

I. Review the work of other trades, and provide necessary bends, offsets, duct enlargements and stream-lined pipe and hanger casings to eliminate conflicts.

J. Duct sizes shown on plans are net interior dimensions. Adjust sheet metal size to account for interior duct lining.

2.03 DUCT MANUFACTURERS

A. Metal-Fab, Inc.

B. SEMCO Incorporated

C. United McGill Corporation

D. Kirk & Blum

2.04 MANUFACTURED METAL DUCTWORK AND FITTINGS

A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Flat Oval Ducts: Machine made from round spiral lockseam duct with light reinforcing corrugations; fittings manufactured of at least two gages heavier metal than duct.

1. Manufacturers:

a. United McGill Corporation

C. Double Wall Insulated Flat Oval Ducts: Machine made from round spiral lockseam duct with light reinforcing corrugations, galvanized steel outer wall, 1 inch thick fiberglass insulation, perforated galvanized steel inner wall; fittings manufactured with solid inner wall.

1. Manufacturers:

a. United McGill Corporation

D. PVC Coated Steel Ducts: UL 181, Class 1, galvanized steel duct coated with 4 mil polyvinyl chloride plastic on both sides.

E. Slab Duct Ventilation System: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS, with G90/Z275 coating; corrugated, in standard sizes with support brackets, connecting couplings, elbows, end caps, spin-in-collar, wall discharge head, and soffit discharge head; designed for installation in cast-in-place concrete floor assemblies.

F. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, 1 inch thick fiberglass insulation, perforated galvanized steel inner wall; fitting with solid inner wall.

G. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.05 CASINGS

A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and construct for operating pressures indicated.

B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

1. Provide clear wire glass observation ports, minimum 6 x 6 inch size.

D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb./cu ft. minimum glass fiber media, on inverted channels of 16 gage.

2.06 KITCHEN HOOD EXHAUST DUCTWORK

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and NFPA 96.

B. Provide temporary protective coating on kitchen exhaust ductwork.

C. Construct of 16 gage carbon steel or 18 gage stainless steel, using continuous external welded joints.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

C. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

G. Use double nuts and lock washers on threaded rod supports.

H. Slope underground ducts to plenums or low pump out points at 1:500. Provide access doors for inspection.

I. Paint buried metal ductwork without factory jacket with one coat and seams and joints with additional coat of asphalt base protective coating.

J. Encase buried metal ductwork in 3 inch minimum of concrete. Provide adequate tie-down points to prevent ducts from floating during concrete placement. Introduce no heat into ducts for 20 days following placement of concrete.

K. Tape joints of PVC coated metal ductwork with PVC tape.

L. Insulate buried supply duct runs over 70 feet long with 1 inch thick insulation covered with plastic vapor barrier.

M. Connect terminal units to supply ducts with 1 foot maximum length of flexible duct. Do not use flexible duct to change direction.

N. Connect diffusers or light troffer boots to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.

O. Connect flexible ducts to metal ducts with liquid adhesive plus tape; draw bands; or adhesive plus sheet metal screws.

P. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

Q. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out.

R. Use stainless steel with 2B finish for ductwork exposed to view and stainless steel with 2D finish for ducts where concealed.

S. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

T. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

3.02 CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

B. Clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

3.03 SCHEDULES

A. Ductwork Material:

1. Low Pressure Supply (Heating Systems): Steel, Aluminum.

2. Low Pressure Supply (System with Cooling Coils): Steel, Aluminum.

3. Medium and High Pressure Supply: Steel.

4. Return and Relief: Steel, Aluminum.

5. General Exhaust: Steel, Aluminum.

6. Kitchen Hood Exhaust: Steel, Stainless Steel.

7. Dishwasher Exhaust: Stainless Steel, Glass Fiber Reinforced Plastic.

8. Outside Air Intake: Steel.

9. Combustion Air: Steel.

B. Ductwork Pressure Class:

1. Supply - 2 inches, minimum in main; 1 inch downstream of terminal unit.

2. Return and relief - 1 inch, minimum.

3. General exhaust - 1 inch, minimum.

4. Hood exhaust - 2 inches, minimum.

END OF SECTION 23 3100

SECTION 23 3300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Air turning devices/extractors.

B. Backdraft dampers.

C. Combination fire and smoke dampers.

D. Duct access doors.

E. Duct test holes.

F. Fire dampers.

G. Flexible duct connections.

H. Smoke dampers.

I. Volume control dampers.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association.

B. NFPA 92A - Standard on Smoke-Control Systems; National Fire Protection Association.

C. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.

D. UL 33 - Heat Responsive Links for Fire-Protection Service; Underwriters Laboratories Inc.

E. UL 555 - Standard for Fire Dampers; Underwriters Laboratories Inc..

F. UL 555S - Standard for Leakage Rated Dampers for Use in Smoke Control Systems; Underwriters Laboratories Inc.

1.04 SUBMITTALS

A. Product Data: Provide for shop fabricated assemblies, including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.

B. Shop Drawings: Indicate for shop fabricated assemblies, including volume control dampers, duct access doors, and duct test holes.

C. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.

1.05 PROJECT RECORD DOCUMENTS

A. Record actual locations of access doors, test holes, and fire dampers and fire/smoke dampers.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc.; or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

1.08 EXTRA MATERIALS

A. Provide two of each size and type of fusible link.

PART 2 - PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:

1. Krueger
2. Ruskin Company
3. Titus

B. Multi-blade device with blades aligned in short dimension; steel or aluminum to suit duct construction; with individually adjustable blades, mounting straps.

C. Multi-blade device with radius blades attached to pivoting frame and bracket, steel or aluminum construction, with push-pull operator strap, ceiling mounted rotary operator knob, or worm drive mechanism with removable key operator, as indicated.

2.02 BACKDRAFT DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc.

2. Nailor Industries Inc.

3. Ruskin Company

B. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: galvanized steel or extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc.

2. Nailor Industries Inc.

3. Ruskin Company

4. Lloyd Industries

5. Air Balance, Inc.

B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

C. Provide factory sleeve and collar for each damper.

D. Multiple Blade Dampers: Fabricate with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

E. Operators: UL listed and labeled spring return pneumatic type suitable for operation on 0-20 psig instrument air. Provide end switches to indicate damper position. Locate damper operator on interior or exterior of duct and link to damper operating shaft.

F. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior or exterior of duct and link to damper operating shaft.

G. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.

H. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.

I. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.04 DUCT ACCESS DOORS

A. Manufacturers:

1. Nailor Industries Inc.

2. Ruskin Company

3. SEMCO Incorporated

4. Durodyne

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.

1. Less Than 12 inches Square: Secure with sash locks.

2. Up to 18 inches Square: Provide two hinges and two sash locks.

3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.

4. Larger Sizes: Provide an additional hinge.

D. Access doors with sheet metal screw fasteners are not acceptable.

2.05 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.06 FIRE DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc.

2. Nailor Industries Inc.

3. Ruskin Company

4. Lloyd Industries

5. Air Balance, Inc.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Ceiling Dampers: Galvanized steel, 22 gage frame and 16 gage flap, two layers 0.125 inch ceramic fiber on top side with locking clip.

D. Horizontal Dampers: Galvanized steel, 22 gage frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations or closure under air flow conditions. Configure with blades out of air stream.

F. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.07 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. Flexible Duct Connections: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz. per sq. yd. for general application indoors. Ductwork exposed to weather, fabric shall be hypalon-coated woven fiberglass. For kitchen exhaust, fabric shall be neoprene-coated woven fiberglass.

a. Net Fabric Width: Approximately 2 inches wide.

2. Metal: 3 inches wide thick galvanized steel.

C. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs. per sq. ft., 10 dB attenuation in 10 to 10,000 Hz range.

2.08 SMOKE DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc.

2. Nailor Industries Inc.

3. Ruskin Company

4. Lloyd Industries.

5. Air Balance, Inc.

B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

C. Dampers: UL Class 1 curtain or multiple blade type fire damper, normally open or closed automatically operated by pneumatic or electric actuator.

D. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.09 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc.

2. Nailor Industries Inc.

3. Ruskin Company

4. Durodyne.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

F. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.

2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

3. Where rod lengths exceed 30 inches provide regulator at both ends.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.

G. Demonstrate re-setting of fire dampers to Owner's representative.

H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

J. For fans developing static pressures of 5.0 inches and over, cover flexible connections with leaded vinyl sheet, held in place with metal straps.

K. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.

L. Provide balancing dampers on high velocity systems where indicated.

M. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 23 3300

SECTION 23 3416 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Backward inclined centrifugal fans.

B. Forward curved centrifugal fans.

C. Airfoil centrifugal fans.

D. Motors and drives.

E. Fan accessories.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.

B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; American Bearing Manufacturers Association, Inc.

C. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.

D. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; (ANSI/AMCA 210, same as ANSI/ASHRAE 51).

E. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; http://www.amca.org/licenses/search.aspx.

F. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.

G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.

H. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.

I. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.

1.04 PERFORMANCE REQUIREMENTS

A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. Fabrication: Conform to AMCA 99.

D. Performance Base: Sea level conditions.

E. Temperature Limit: Maximum 300 degrees F.

F. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

G. Air Flow: As scheduled on the drawings.

H. Static Pressure: As scheduled on the drawings.

I. Motor: As scheduled on the drawings.

1.05 SUBMITTALS

A. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

B. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Include complete installation instructions.

D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Protect motors, shafts, and bearings from weather and construction dust.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

1.09 EXTRA MATERIALS

A. Supply two sets of belts for each fan.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ACME Engineering and Manufacturing Corporation

B. Loren Cook Company

C. PennBarry

D. Greenheck Fan Corporation

2.02 WHEEL AND INLET

A. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

B. Forward Curved: Galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to back plate and keyed to shaft with set screw.

C. Airfoil Wheel: Steel construction with smooth curved inlet flange, heavy back plate die formed hollow airfoil shaped blades continuously welded at tip flange, and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

D. Radial: Steel construction with heavy back plate, plate blades welded or riveted to back plate, cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

2.03 HOUSING

A. Heavy gage steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cutoff.

B. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, fabricate of galvanized steel.

C. Provide bolted construction with horizontal flanged split housing, where indicated.

D. Fabricate plug fans without volute housing, in lined steel cabinet.

E. Provide flanged inlet and outlet where scheduled.

2.04 BEARINGS AND DRIVES

A. Bearings: Heavy duty pillow block type, selfgreasing ball bearings, with ABMA 9 life at 50,000 hours or roller bearings, or ABMA 11, life at 120,000 hours.

B. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.

C. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp (11.2 kW) and under, selected so required rpm is obtained with sheaves set at mid Fixed sheave for 20 hp (15 kW) and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

D. Belt Guard: Fabricate to SMACNA Duct Construction Standards - Metal and Flexible; 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.05 ACCESSORIES

A. Fixed Inlet Vanes: Steel construction with fixed cantilevered inlet guide vanes welded to inlet bell.

B. Adjustable Inlet Vanes: Steel construction with blades supported at both ends with two permanently lubricated bearings, variable mechanism terminating in single control lever with control shaft for double width fans.

C. Discharge Dampers: Parallel blade heavy duty steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.

D. Inlet/Outlet Screens: Galvanized steel welded grid.

E. Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.

F. Scroll Drain: 1/2 inch steel pipe coupling welded to low point of fan scroll.

G. Flanged Inlet and Outlet: As scheduled on the drawings.

H. Vibration Isolators

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install fans with resilient mountings and flexible electrical leads.

C. Install flexible connections between fan inlet and discharge ductwork; refer to Section 23 3300. Ensure metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.

D. Install fan restraining snubbers. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

E. Provide fixed sheaves required for final air balance.

F. Provide safety screen where inlet or outlet is exposed.

G. Pipe scroll drains to nearest floor drain.

H. Provide backdraft dampers on discharge of exhaust fans and as indicated.

END OF SECTION 23 3416

SECTION 23 3423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Roof exhausters.

B. Cabinet fans.

C. Ceiling exhaust fans.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.

B. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; (ANSI/AMCA 210, same as ANSI/ASHRAE 51).

C. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; http://www.amca.org/licenses/search.aspx.

D. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.

E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.

F. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.

G. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association.

H. UL 705 - Power Ventilators; Underwriters Laboratories Inc.

1.04 SUBMITTALS

A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

B. Manufacturer's Instructions: Indicate installation instructions.

C. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

1.07 EXTRA MATERIALS

A. Supply two sets of belts for each fan.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Greenheck

B. Loren Cook Company

C. PennBarry

2.02 ROOF EXHAUSTERS OR VENTILATORS

A. Product Requirements:

1. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

2. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.

3. Fabrication: Conform to AMCA 99.

4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

B. Performance and electrical characteristics as scheduled on the drawings.

C. Fan Unit: V-belt or direct driven as indicated, with spun aluminum or upblast spun aluminum with grease tray housing for kitchen exhaust fans, resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

D. Roof Curb: 8 inch, 12 inch, 16 inch, 20 inch, 24 inch high self-flashing of galvanized steel or aluminum with continuously welded seams, built-in cant strips, insulation and curb bottom, interior baffle with acoustic insulation, curb bottom, ventilated double wall, hinged curb adapter, and factory installed nailer strip.

E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch, and wall mounted multiple speed switch or solid state speed controller, and wall mounted solid state speed controller.

F. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

G. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.03 CABINET AND CEILING EXHAUST FANS

A. Performance and electrical characteristics as scheduled on the drawings.

B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.

C. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch, and wall mounted multiple speed switch, and wall mounted solid state speed controller.

D. Grille: Molded white plastic, Aluminum, or Aluminum with baked white enamel finish.

E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof or wall exhausters with cadmium plated steel or stainless steel lag screws to roof curb or structure.

C. Extend ducts to roof or wall exhausters into roof curb or structure. Counterflash duct to roof or wall opening.

D. Hung Cabinet Fans:

1. Install fans with resilient mountings and flexible electrical leads.

2. Install flexible connections between fan and ductwork. Ensure metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.

E. Provide sheaves required for final air balance.

F. Install backdraft dampers on inlet to roof and wall exhausters.

G. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION 23 3423

SECTION 23 3700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

C. Door grilles.

D. Louvers.

E. Roof hoods.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.

B. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute.

C. ASHRAE Std 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

D. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.

1.04 SUBMITTALS

A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level. Submit color chart.

B. Samples: Submit one of each required air outlet and inlet type.

C. Project Record Documents: Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.

B. Test and rate louver performance in accordance with AMCA 500-L.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Carnes Company HVAC

B. Krueger

C. Price Industries

D. Titus

E. Tuttle and Bailey

2.02 RECTANGULAR CEILING DIFFUSERS

A. Type: Square and rectangular, adjustable pattern, multi-louvered diffuser to discharge air in pattern indicated on the drawings.

B. Frame: Surface mount. In plaster ceilings, provide plaster frame and ceiling frame.

C. Fabrication: Aluminum with baked enamel finish.

D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 CEILING SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.

B. Frame: 1-1/4 inch margin with concealed mounting and gasket.

C. Fabrication: Aluminum extrusions with factory finish.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.04 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical or horizontal face.

B. Frame: 1-1/4 inch margin with concealed mounting.

C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory finish, color to be selected.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.05 CEILING LINEAR EXHAUST AND RETURN GRILLES

A. Type: Streamlined blades with 90 degree two-way deflection, 1/8 x 3/4 inch on 1/2 inch centers.

B. Frame: 1-1/4 inch margin, extra heavy for floor mounting, with concealed mounting.

C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory finish, color to be selected.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.06 CEILING SLOT DIFFUSERS

A. Type: Continuous 1/2 inch, 3/4 inch or 1 inch wide slot, one, two, three or four slots wide as scheduled, with adjustable vanes for left, right, or vertical discharge.

B. Fabrication: Aluminum extrusions or steel with factory finish, color to be selected.

C. Frame: 1-1/4 inch margin with countersunk screw, concealed, support clips for suspension system, or support clips for T-bar mounting and gasket, mitered end border.

D. Plenum: Integral, galvanized steel, insulated.

2.07 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, double deflection.

B. Frame: 1-1/4 inch margin with concealed mounting and gasket.

C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory finish, color to be selected.

D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.08 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille with two-way deflection.

B. Frame: 1-1/4 inch margin with concealed mounting and gasket.

C. Fabrication: Aluminum extrusions with factory finish.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.09 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.

B. Frame: 1-1/4 inch margin with concealed mounting.

C. Fabrication: Steel frames and blades, with factory finish, color to be selected.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.10 DOOR GRILLES

A. Type: V-shaped louvers of 20 gage thick steel, 1 inch deep on 1/2 inch centers.

B. Frame: 20 gage steel with auxiliary frame to give finished appearance on both sides of door, with factory prime coat finish.

2.11 LOUVERS

A. Type: 6 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust, and 1/2 inch square mesh screen over intake.

B. Fabrication: 16 gage thick galvanized steel welded assembly, with factory finish, color to be selected.

C. Fabrication: 12 gage thick extruded aluminum, welded assembly, with factory finish color to be selected.

D. Mounting: Furnish with exterior flat flange for installation.

2.12 ROOF HOODS

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Fabricate of galvanized steel, minimum 16 gage base and 20 gage hood, or aluminum, minimum 16 gage base and 18 gage hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory finish.

C. Fabricate louver penthouses with mitered corners and reinforce with structural angles.

D. Mount unit on minimum 12 inch high curb base with insulation between duct and curb.

E. Make hood outlet area minimum of twice throat area.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black.

END OF SECTION 23 3700

SECTION 23 7413 - PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Packaged roof top unit.

B. Unit controls.

C. Remote panel.

D. Roof mounting curb and base.

E. Maintenance service.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning and Refrigeration Institute.

B. ARI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning and Refrigeration Institute.

C. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems; National Fire Protection Association.

1.04 PERFORMANCE REQUIREMENTS

A. Gas Heating: As scheduled on the drawings.

B. Cooling Capacity: As scheduled on the drawings.

C. Supply Air Flow and Pressure: As scheduled on the drawings.

E. Return Air Flow and Pressure: As scheduled on the drawings.

E. Unit Sound Rating: Maximum 100 db.

G. Scheduled Performance:

1. Cooling capacity: ARI 210/240 test conditions.

2. Cooling capacity: 95 degrees F condenser ambient air.

3. Sound Rating Numbers: ARI 270.

4. Supply Air: Corrected to 0 feet altitude.

1.05 SUBMITTALS

A. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

B. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

C. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

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

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.08 WARRANTY

A. Provide a five year warranty to include coverage for refrigeration compressors and gas-fired heat exchangers.

1.09 MAINTENANCE SERVICE

A. Furnish service and maintenance of packaged roof top units for one year from Date of Substantial Completion.

B. Provide maintenance service with a two month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.

D. Submit copy of service call work order or report, and include description of work performed.

1.10 EXTRA MATERIALS

A. Provide one set of filters.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The Carrier Corporation

B. The Trane Company

C. York International Corporation

D. McQuay International

E. AAON, Inc.

2.02 AIR CONDITIONING UNITS

A. General: Roof mounted units having gas burner and electric refrigeration.

B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, heat exchanger and burner, hot gas bypass, enthalpy wheel, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

C. Electrical Characteristics:

1. As scheduled on the drawings.

D. Disconnect Switch: Factory mount disconnect switch in control panel or on equipment.

2.03 FABRICATION

A. Cabinet: Galvanized steel with baked enamel finish, including access panels with screwdriver operated flush cam type fasteners. Structural members shall be minimum 18 gage, with access doors or panels of minimum 20 gage.

B. Insulation: 2 inch thick neoprene coated glass fiber with edges protected from erosion.

C. Heat Exchangers: Stainless steel, of welded construction.

D. Supply and Return Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley, and rubber isolated hinge mounted high efficiency motor or direct drive as indicated. Isolate complete fan assembly.

E. Air Filters: 2 inch thick glass fiber disposable media in metal frames.

F. Roof Mounting Curb: 14 inches high galvanized steel, channel frame with gaskets, nailer strips.

2.04 BURNER

A. Gas Burner: Forced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shutoff pilot.

B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after air flow proven and slight delay, allow gas valve to open.

C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.

D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, with provisions for continuous fan operation.

2.05 EVAPORATOR COIL

A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.

B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons (21 kW) capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons (26 kW) cooling capacity and larger.

2.06 COMPRESSOR

A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gage ports, and filter drier.

B. Five minute timed off circuit to delay compressor start.

C. Outdoor thermostat to energize compressor above 35 degrees F ambient.

D. Provide step capacity control by hot gas by-pass and cycling multi-speed compressors.

2.07 CONDENSER COIL

A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.

B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.

C. Provide refrigerant pressure switches to cycle condenser fans.

2.08 MIXED AIR CASING

A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper to fall to closed position. Relief dampers may be gravity balanced.

B. Gaskets: Provide tight fitting dampers with edge gaskets.

C. Gaskets: Provide tight fitting dampers with edge gaskets maximum leakage 5 percent at 2 inches pressure differential.

D. Damper Operator: 24 volt with gear train sealed in oil.

E. Damper Operator, Units 7.5 Ton (26 kW) Cooling Capacity and Larger: 24 volt with gear train sealed in oil with spring return on.

F. Damper Operator: Pneumatic piston or gear driven type with spring return and pilot positioner.

G. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and above 75 degrees F ambient, [or when ambient air temperature exceeds return air temperature] [or when ambient air enthalpy exceeds return air enthalpy].

2.09 OPERATING CONTROLS

A. Provide low voltage, adjustable room thermostat to control burner operation, compressor and condenser fan, and supply fan to maintain temperature setting.

1. Include system selector switch (heat-off-cool) and fan control switch (auto-on).

2. Provide double acting thermostat as indicated per schedules on the drawings.

3. Locate thermostat in room as shown.

B. Provide terminal strip on unit for connection of operating controls to remote panel [by others]. Control shall allow for two stages of heating and two stages cooling.

C. Provide remote mounted fan control switch (on-auto).

D. Provide low limit thermostat in supply air to close outside air damper and stop supply fan.

E. Provide night control energized by central time clock to maintain night thermostat setting.

F. Provide remote readout panels containing signal lights indicating system status, heating system failure, cooling system failure, and dirty filters; check switches proving signal light operations; system on-off switch, and cooling system on-off switch.

G. Provide in panel a 7 day time clock for energizing night control, remote damper control, low limit manual reset, and remote thermostat temperature set point.

2.10 OPERATING CONTROLS - SINGLE ZONE UNITS

A. Electric solid state microcomputer based room thermostat, located as indicated in service area with remote sensor located as indicated.

B. Room thermostat shall incorporate:

1. Automatic switching from heating to cooling.

2. Preferential rate control to minimize overshoot and deviation from set point.

3. Set-up for four separate temperatures per day.

4. Instant override of set point for continuous or timed period from one hour to 31 days.

5. Short cycle protection.

6. Programming based on weekdays, Saturday and Sunday.

7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.

C. Room thermostat display shall include:

1. Time of day.

2. Actual room temperature.

3. Programmed temperature.

4. Programmed time.

5. Duration of timed override.

6. Day of week.

7. System model indication: heating, cooling, auto, off, fan auto, fan on.

8. Stage (heating or cooling) operation.

D. Provide low limit thermostat in supply air to close outside air dampers and stop supply fan.

2.11 OPERATING CONTROLS - VARIABLE VOLUME UNITS

A. Temperature transmitter located in supply air shall signal electronic logic panel to control mixing dampers and cooling in sequence. Mixing section shall operate as first stage of cooling and revert to minimum outside air above approximately 75 degrees F as determined by enthalpy of return and outdoor air.

B. Control cooling by cycling compressors, cylinder unloading, and hot gas bypass.

C. Control logic shall allow supply air reset under low load or airflow conditions.

D. Seven day time clock with spring carry over (or electronic clock with battery backup) shall control unit on occupied/unoccupied schedule. At night, unit shall be off. Locate clock in remote control panel with status lights.

E. Provide two stage morning warm-up thermostat to hold outdoor dampers closed and energize heat until return air temperature reaches set point.

F. Provide within roof curb, by-pass dampers, bypassing air from supply fan discharge to return fan inlet to control duct static pressures. Control operation by sensing current to supply fan motor.

PART 3 - EXECUTION

3.01 EXAMINATION

A Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings or illustrated by the manufacturer

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

D. Locate remote panels where indicated on drawings.

3.03 STARTING EQUIPMENT AND SYSTEMS

A. Provide initial start-up and shut-down during first year of operation, including routine servicing and check-out.

END OF SECTION 23 7413

SECTION 23 7433 - PACKAGED INDOOR HEATING AND COOLING MAKE-UP AIR UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Direct fired make-up air heater.

B. Service platform.

C. Controls.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 REFERENCES

A. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning and Refrigeration Institute.

B. ARI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning and Refrigeration Institute.

C. ARI 520 - Positive Displacement Condensing Units; Air-Conditioning and Refrigeration Institute.

D. ASHRAE Std 23 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

E. ASHRAE Std 90.1 - Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

F. ASHRAE Std 90.2 - Energy Efficient Design of New Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

G. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.

H. NFPA 54 - National Fuel Gas Code; National Fire Protection Association.

I. NFPA 70 - National Electrical Code; National Fire Protection Association.

J. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association.

K. UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical; Underwriters Laboratories Inc.

1.04 PERFORMANCE REQUIREMENTS

A. Performance Ratings: Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than requirements of ASHRAE Std 90.1.

B. Heating Capacity: As scheduled on the drawings.

C. Scheduled Performance: As scheduled on the drawings.

1.05 SUBMITTALS

A. Product Data: Provide data with dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.

B. Shop Drawings: Indicate dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.

C. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

D. Project Record Documents: Record actual locations of components.

E. Operation And Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

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

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.07 REGULATORY REQUIREMENTS

A. Conform to NFPA 70 and requirements of authorities having jurisdiction.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.08 WARRANTY

A. Provide five year manufacturer's warranty for compressor/condenser unit.

1.09 MAINTENANCE SERVICE

A. Provide service and maintenance of units for one year from Date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Provide two sets of filters.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Greenheck

B. I.C.E. (Industrial Commercial Equipment Manufacturing Ltd.)

C. Applied Air/Mestek Technology, Inc.

D. AAON, Inc.

2.02 MANUFACTURED UNITS

A. Unit: Indoor unit.

B. Construction and Ratings: In accordance with ARI 210/240 and UL 207. Testing: ASHRAE Std 23.

2.03 FABRICATION

A. Casing and Components: Steel panels, 18 gage reinforced with structural angles and channels to ensure rigidity; access panels to burner and blower motor assemblies from either side of unit.

B. Observation Port: On burner section for observing main and pilot flames.

C. Insulation: Neoprene faced glass fiber insulation 1 inch thick on complete unit.

D. Finish: Heat resistant baked enamel.

E. Suspended Installations: Service platforms complete with handrails and access ladder.

F. Outdoor Installation: Weatherproofed casing, with intake louver or hood.

2.04 FILTERS

A. Filter: Removable 2 inches thick glass fiber disposable filters in metal frames.

2.05 BURNERS

A. Assembly: For natural gas, capable of modulating turn down ratio of 4:1, including electric modulating main gas valve, motorized shut down valve, main and pilot gas regulators, pilot electric gas valve, manual shut-off valve and pilot adjustment valve.

B. Regulator: Required for initial gas pressure of 6 inch WG.

C. Pilot: Electrically ignited by spark rod through high voltage ignition transformer.

D. Damper: Motorized with end switch to prove position before burner will fire.

2.06 FAN

A. Fan: Statically and dynamically balanced centrifugal fan mounted on solid steel shaft with heavy duty self-aligning pre-lubricated ball bearings and V-belt drive with matching motor sheaves and belts.

B. Electrical Characteristics: As scheduled on the drawings.

2.07 CONTROLS

A. Controls: Pre-wire unit for connection of power supply. Field wiring from unit to remote control panel makes unit operative.

B. Remote Control Panel: On-off-auto switch, indicating lights for supply fan, exhaust fan, pilot operation, burner operation, lockout indication, and clogged filter indication.

C. Interlocks: Unit to start when exhaust fan is running. Burner to operate when flow switch located in exhaust duct proves flow.

D. Fan Discharge Thermostat: Controls modulating gas valve to maintain supply air temperature.

1. Provide room thermostat to reset discharge thermostat minimum of three temperature levels.

E. Timer: Operates fan system off at night.

F. Carbon Monoxide Monitoring System: Operates fan on high volume when pre-determined carbon monoxide concentration is detected.

G. Night Thermostat: Thermostat set at 50 degrees F energizes system on low temperature.

H. Safety Controls: Sense correct air flow before energizing pilot and sense pilot ignition before activating main gas valve.

I. Manual Reset Low and High Limit Controls: Maintain supply air temperature between set points and shut fan down if temperatures are exceeded.

J. Purge Period Timer: Automatically delays burner ignition and bypass low limit control.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install to NFPA 90A.

C. Install to NFPA 54. Provide connection to fuel gas system.

D. Install unit on vibration isolators.

E. Provide flexible duct connections on outlet from unit.

END OF SECTION 23 7433

SECTION 23 8100 - DECENTRALIZED HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

A. The variable capacity, heat pump heat recovery air conditioning system shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system.

1.02 QUALITY ASSURANCE

A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

E. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

1.03 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendation.

1.04 CONTROLS

A. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

B. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.

C. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.

D. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.

E. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.

F. System shall be capable of email generation for remote alarm annunciation.

G. Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in Mitsubishi Electric controls system configuration and operation. The representative shall provide proof of certification for Mitsubishi Electric Controls Applications Training indicating successful completion of no more than two years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one, eight hour period to be completed during normal working hours.

1.05 WARRANTY

A. The CITY MULTI units shall be covered by the manufacturer's limited warranty for a period of one year parts and seven year compressor to the original owner from date of installation.

1. If the systems are designed by a certified CITY MULTI Diamond Designer using Diamond System Builder, installed by a contractor that has successfully completed the Mitsubishi Electric three day service course, and verified with required materials submitted to and approved by the Mitsubishi Electric Service Department, which include:

   - As-built Diamond System Builder file
   - A one hour Maintenance Tool record with system information, in Ordinary Control Mode (not initial)
   - Outdoor and Indoor unit dip switch settings
   - Outdoor units function settings

   then the units shall be covered by an extended manufacturer's limited warranty for a period of ten years to the original owner from date of installation.

2. In addition the compressor shall have a manufacturer's limited warranty for a period of ten years to the original owner from date of installation.

3. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

4. This warranty shall not include labor.

B. Manufacturer shall have a minimum of 33 years of HVAC experience in the U.S. market.

C. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

D. The CITY MULTI VRF system shall be installed by a contractor with extensive CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

PART 2 - PRODUCTS

2.01 L-GENERATION R2-SERIES OUTDOOR UNIT

A. The R2-Series PURY outdoor unit shall be used specifically with CITY MULTI VRF components. The PURY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

1. The model nomenclature and unit requirements are shown below. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing lines. If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.

Outdoor Unit Model Nomenclature		
208/230 Volt		
Model Number	**Units**	**Twinning Kit**
PURY-P288TSLMU	(2) PURY-P144TLMU	CMY-ER200CBK
PURY-P312TSLMU	(1) PURY-P144TLMU (1) PURY-P168TLMU	CMY-ER200CBK

2. Outdoor unit shall have a sound rating no higher than 61 dB(A) individually or 64 dB(A) twinned. Units shall have a sound rating no higher than 51 dB(A) individually or 54 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

3. Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated in accordance with the installation manual.

4. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.

5. There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.

6. Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.

7. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.

8. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.

9. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 1804-3100 feet. The greatest length is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.

10. The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperatures or cooling mode down to 23°F ambient temperatures, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.

11. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

12. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.

B. Unit Cabinet:

1. The casings shall be fabricated of galvanized steel, bonderized and finished. Units cabinets shall be able to withstand 960 hours per ASTM B117 criteria for seacoast protected models (-BS models)

C. Fan:

1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.

2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.

3. All fan motors shall be mounted for quiet operation.

4. All fans shall be provided with a raised guard to prevent contact with moving parts.
5. The outdoor unit shall have vertical discharge airflow.

D. Refrigerant:

1. R410A refrigerant shall be required for PURY-P-T/Y(S)KLU outdoor unit systems.

2. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

E. Coil:

1. The outdoor Hexicoil™ heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction.

2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.

3. A stainless steel pipe connects the aluminum coil to copper piping.

4. The coil shall be protected with an integral metal guard.

5. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

6. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

F. Compressor:

1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.

2. A crankcase heater shall be factory mounted on the compressor.

3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 15%-5% of rated capacity, depending upon unit size.

4. The compressor will be equipped with an internal thermal overload.

5. The compressor shall be mounted to avoid the transmission of vibration.

6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

G. Controls:

1. The outdoor unit shall have the capability of up to 8 levels of demand control for each refrigerant system

H. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.

2. The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz), 207-253V (230V/60Hz).

3. The outdoor unit shall be controlled by integral microprocessors.

4. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.02 BRANCH CIRCUIT (BC) CONTROLLERS FOR R2-SERIES SYSTEMS

A. General

1. The BC (Branch Circuit) Controllers shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit for heating or subcooled liquid refrigerant to flow to indoor unit for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling risk bubbles in liquid supplied to LEV and are not allowed.

2. The BC (Branch Circuit) Controllers shall be specifically used with R410A R2-Series systems. These units shall be equipped with a circuit board that interfaces to the M-NET controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity. The BC Controller shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. BC Unit Cabinet:

1. The casing shall be fabricated of galvanized steel.
2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves. The unit shall house two tube-in-tube heat exchangers.

C. Refrigerant:

1. R410A refrigerant shall be required.

D. Refrigerant Branches:

1. All BC Controller refrigerant pipe connections shall be brazed or flared.

E. Refrigerant valves:

1. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.

2. Each branch shall have multiple two-position valves to control refrigerant flow.

3. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.

4. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

F. Integral Drain Pan:

1. An Integral resin drain pan and drain shall be provided

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 Hertz.

2. The unit shall be capable of satisfactory operation within voltage limits of 187-228 (208V/60Hz) or 207-253 (230/60Hz).

3. The BC Controller shall be controlled by integral microprocessors

4. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.03 PMFY (1-WAY CEILING-RECESSED CASSETTE WITH GRILLE) INDOOR UNIT

A. General:

1. The PMFY shall be a one-way cassette indoor unit that recesses into the ceiling with a ceiling grille and shall have a modulating linear expansion device. The PMFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PMFY shall support individual control using M-NET DDC controllers.

B. Indoor Unit.

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function

and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:

1. The cabinet shall be space-saving ceiling recessed.

2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

3. Branch ducting shall be allowed from cabinet.

4. The one-way grille shall be fixed to bottom of cabinet allowing for one-way airflow.

D. Fan:

1. The indoor fan shall be an assembly with one line-flow fan direct driven by a single motor.

2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.

3. The indoor fan shall consist of four speeds, Low, Mid1, Mid2, and High.

E. Filter:

1. Return air shall be filtered by means of a long-life washable permanent filter.

F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.

2. The tubing shall have inner grooves for high efficiency heat exchange.

3. All tube joints shall be brazed with phos-copper or silver alloy.

4. The coils shall be pressure tested at the factory.

5. A condensate pan and drain shall be provided under the coil.

6. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 23 inches above the condensate pan.

7. Both refrigerant lines to the PMFY indoor units shall be insulated in accordance with the installation manual.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. Controls:

1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F - 9.0°F adjustable deadband from set point.

4. Indoor unit shall include no less than four digital inputs capable of being used for customizable control strategies.

5. Indoor unit shall include no less than three digital outputs capable of being used for customizable control strategies.

2.04 PEFY-NMAU (CEILING-CONCEALED DUCTED) INDOOR UNIT

A. General:

1. The PEFY shall be a ceiling-concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The PEFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY shall support individual control using M-NET DDC controllers. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Indoor Unit:

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:

1. The unit shall be, ceiling-concealed, ducted.

2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

D. Fan:

1. PEFY-NMAU models shall feature external static pressure settings from 0.14 to 0.60 in. WG.

2. The indoor unit fan shall be an assembly with one or two Sirocco fan direct driven by a single motor.

3. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.

4. The indoor fan shall consist of three speeds, High, Mid, and Low plus the Auto-Fan function.

5. The indoor unit shall have a ducted air outlet system and ducted return air system.

E. Filter:

1. Return air shall be filtered by means of a standard factory installed return air filter.

2. Optional return filter box (rear or bottom placement) with high-efficiency filter shall be available for all PEFY indoor units.

F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.

2. The tubing shall have inner grooves for high efficiency heat exchange.

3. All tube joints shall be brazed with phos-copper or silver alloy.

4. The coils shall be pressure tested at the factory.

5. A condensate pan and drain shall be provided under the coil.

6. The condensate shall be gravity drained from the fan coil.

7. Both refrigerant lines to the PEFY indoor units shall be insulated in accordance with the installation manual.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. Controls:

1. This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.05 CONTROLS

A. The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.

B Electrical Characteristics:

1. The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

2. Wiring:

a. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

b. Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.

c. Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.

d. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.

e. The AE-200, AE-50, and EB-50GU centralized controller shall be capable of being networked with other AE-200, AE-50, and EB-50GU centralized controllers for centralized control.

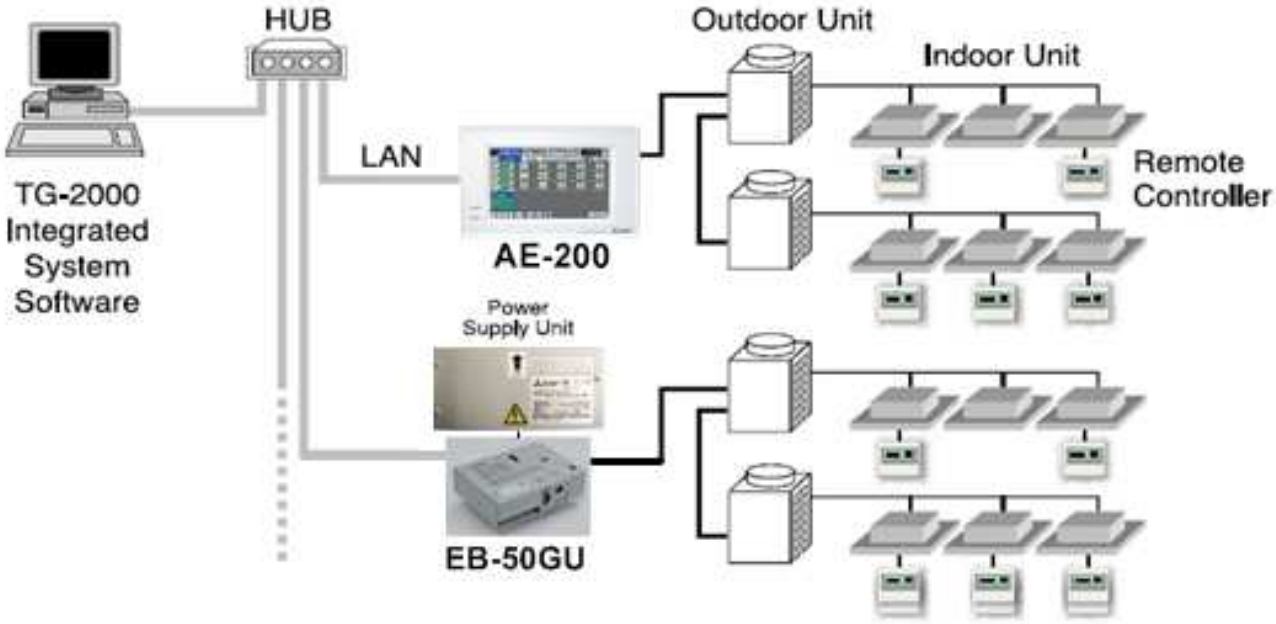
3. Wiring type:

a. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.

b. Network wiring shall be CAT-5 with RJ-45 connection.

2.06 CITY MULTI CONTROLS NETWORK

A. The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.



CMCN System Configuration

B. CMCN: Remote Controllers Backlit Simple MA Remote Controller (PAC-YT53CRAU):

1. The Backlit Simple MA Remote Controller (PAC-YT53CRAU) shall be capable of controlling up to 16 indoor units (defined as 1 group). The Backlit Simple MA Remote Controller shall be compact in size, approximately 3" x 5" and have limited user functionality. The Backlit Simple MA supports temperature display selection of Fahrenheit or Celsius. The Backlit Simple MA Remote Controller shall allow the user to change on/off, mode (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, and fan speed setting and airflow direction. The Backlit Simple MA Remote Controller shall be able to limit the set temperature range from the Backlit Simple MA. The Backlit Simple MA Remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Backlit Simple MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Backlit Simple MA Remote Controller shall display a four-digit error code in the event of system abnormality/error.

2. The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers (PAR-FL32MA-E/PAR-FA32MA-E) or with other Backlit Simple MA Remote Controllers (PAC-YT53CRAU), with up to two remote controllers per group.

3. The Backlit Simple MA Remote Controller shall require no addressing. The Backlit Simple MA Remote Controller shall connect using two-wire, stranded, non-polar control

wire to TB15 connection terminal on the indoor unit. The Simple MA Remote Controller shall require cross-over wiring for grouping across indoor units.

PAC-YT53CRAU (Backlit Simple MA Remote Controller)			
Item	**Description**	**Operation**	**Display**
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F - 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit/ Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display "test run").	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group

2.07 CENTRALIZED CONTROLLER (WEB-ENABLED)

A. AE-200 Centralized Controller:

1. The AE-200A Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three AE-50A expansion controllers. The AE-200A Centralized Controller shall be approximately 11-5/32" x 7-55/64" x 2-17/32" in size and shall be powered with an integrated 100-240 VAC power supply. The AE-200A Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the AE-200A Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the AE-200 Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the AE-200A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the AE-200A Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

AE-200 (Centralized Controller)			
Item	**Description**	**Operation**	**Display**
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature from 57°F - 87°F depending on operation mode and indoor unit.	Each Block, Group or Collective	Each Group
Fan Speed\Setting	Available fan speed settings depending on indoor unit.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group

AE-200 (Centralized Controller)			
Item	**Description**	**Operation**	**Display**
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Setback Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit/ Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Room Temp	Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Outdoor Unit Status	Compressor capacity percentage and system pressure (high and low) pressure (excludes S-Series)	Each ODU	Each ODU
Connected Unit Information	MNET addresses of all connected systems	Each IDU, ODU and BC	Each IDU, ODU and BC

AE-200 (Centralized Controller)			
Item	**Description**	**Operation**	**Display**
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between "Hi", "Low" and "Stop". When setting a group of only free plan LOSSNAY units, you can switch between "Normal ventilation", "Interchange ventilation" and "Automatic ventilation".	Each Group	Each Group
Multiple Language	Other than English, the following language can be chosen. Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese are available.	N/A	Collective
External Input / Output	By using accessory cables you can set and monitor the following. Input By level: "Batch start/stop", "Batch emergency stop" By pulse: "batch start/stop", "Enable/disable remote controller" Output: "start/stop", "error/Normal" Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective

2. All AE-200A Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three AE-50A expansion controllers for display of up to two hundred (200) indoor units on the main AE-200A interface.

3. The AE-200A Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.

4. Standard software functions shall be available so that the building manager can securely log into each AE-200A via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Tenant Billing shall be available but are not included. The Tenant Billing function shall require TG-2000 Integrated System software in conjunction with the Centralized Controllers.

B. AE-50A Expansion Controller:

1. The AE-50A Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the AE-200A Centralized Controller for the purpose of adding up

to 50 indoor units to either the main touch screen interface of the AE-200A. Up to three AE-50A expansion controllers can be connected to the AE-200A via a local IP network (and their IP addresses assigned on the AE-200A) to the AE-200A to allow for up to 200 indoor units to be monitored and controlled from the AE-200A interface.

2. The AE-50A expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the AE-200A and configured to display their units on the main controller, the individual indoor units connected to the AE-50A can still be monitored and controlled from the interface of the AE-50. The last command entered will take precedence, whether at the wall controller, the AE-50A or the AE-200A Centralized Controller.

C. Power Supply (PAC-SC51KUA):

1. The power supply shall supply 24VDC (TB3) for the AE-200/AE-50/EB-50GU centralized controller and 30VDC (TB2) voltage for the central control transmission.

END OF SECTION 23 8100

SECTION 23 8101 - TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Unit heaters.

B. Cabinet unit heaters.

1.02 RELATED SECTIONS

A. Drawings and General Provisions of the Contract apply to this section.

1.03 SUBMITTALS

A. Product Data: Provide typical catalog of information including arrangements.

B. Shop Drawings:

1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.

2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

3. Indicate mechanical and electrical service locations and requirements.,

C. Samples: Submit one sample of each radiation cabinet detailed.

D. Manufacturer's Instructions: Indicate installation instructions and recommendations.

E. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.

F. Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

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

1.04 QUALITY ASSURANCE

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

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.05 EXTRA MATERIALS

A. Provide two sets of filters.

PART 2 - PRODUCTS

2.01 UNIT HEATERS

A. Manufacturers:

1. The Trane Company

2. Slant/Fin Corporation

3. Sterling Hydronics/Mestek Technology, Inc.

4. Modine

B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

C. Casing: Minimum 0.0478 inch steel with threaded pipe connections for hanger rods.

D. Finish: Factory applied baked enamel of color as selected.

E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

F. Air Outlet: Adjustable pattern diffuser on projection models and two-way louvers on horizontal throw models.

G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models.

H. Control: Local multi-speed disconnect switch.

I. Capacity: As scheduled on the drawings.

J. Electrical Characteristics: As scheduled on the drawings.

2.02 CABINET UNIT HEATERS

A. Manufacturers:

1. Berko

2. Slant/Fin Corporation

3. Sterling Hydronics/Mestek Technology, Inc.

4. The Trane Company

5. Modine

B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi and 220 degrees F.

C. Cabinet: Minimum 0.0598 inch steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation integral air outlet and inlet grilles. Recessed units shall form plaster stop. Units in ceilings shall have duct collars.

D. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.

E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.

G. Control: Multiple speed switch, factory wired, located in cabinet.

H. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before coil.

I. Mixing Dampers: Where indicated, mixing sections with dampers.

J. Capacity: As Scheduled on the drawings.

K. Electrical Characteristics as scheduled on the drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Do not damage equipment or finishes.

C. Protection: Provide finished cabinet units with protective covers during balance of construction.

D. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

E. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.

F. Units with Cooling Coils: Connect drain pan to condensate drain.

G. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's submittals.

3.02 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filters.

END OF SECTION 23 8101