TECHNICAL SPECIFICATIONS FOR RICHARD A. HEYMAN ENVIRONMENTAL PROTECTION FACILITY – DEEP WELL INJECTION PUMP AND HVAC CITY OF KEY WEST PROJECT ID#: 199322

MICHELE F. ROTH
LICENSE
No. 82002
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

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Michele Roth, P.E.

Date: 2019.12.23 09:22:27-06'00'

Florida Registered Professional Engineer No. 82002

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Building Mechanical

SEAL OF THE CITY OF KEY WEST, FLORIDA

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Black & Veatch
2855 North University Drive, Suite 210
Coral Spring, FL 33065

Section 15050

BASIC MECHANICAL BUILDING SYSTEMS MATERIALS AND METHODS

PART 1 - GENERAL

1-1. SCOPE. This section covers general mechanical building system requirements as referenced from other sections and furnishing and installation of the plumbing and heating, ventilating, and air conditioning systems. Protective coatings for ductwork and equipment without special coatings shall be as specified in the Protective Coatings section.

1-2. GENERAL. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by the Engineer.

1-2.01. Coordination. Where two or more units of the same class of materials are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable local codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

1-2.04. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete information, detailed specifications, and data covering materials, parts, devices, and accessories forming a part of the materials furnished, shall be submitted in accordance with the Submittals Procedures section.

Number Plates

Product data on number plates.

A listing of equipment to receive number plates shall be submitted.

Equipment Motors

Name of Manufacturer.
Type and Model.
Horsepower (kW) rating and service factor.
Temperature rise and insulation rating.
Full load rotative speed.
Type of bearings and method of lubrication.
Net weight.
Overall dimensions.
Efficiency at full, 3/4, and 1/2 loads.
Full load current and power factor.
Locked rotor current.

1-4. QUALITY ASSURANCE.

1-4.01. Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1-4.02. Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section.

2-2.03. Equipment Efficiencies. Unless otherwise indicated in the respective equipment paragraph, the equipment efficiency shall be in accordance with the requirements of ASHRAE Energy Standard 90.1.

2-2.04. Drive Units. Drive units shall be designed for 24 hour continuous service.

2-2.04.01. Electric Motors. Motor horsepower scheduled on the Drawings are minimum motor horsepower. Larger motors shall be provided if required to meet the specified capacities for the equipment furnished. Motors furnished with equipment shall meet the following requirements.

a. Premium efficient motors with a minimum efficiency of at least that specified in the Common Motor Requirements for Process Equipment section shall be provided where available as a standard option. All other motors shall meet the minimum efficiency standards required by the 2007 Energy Independence and Security Act.

b. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

c. Rated for continuous duty at 40°C ambient.

d. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet [1005 m], explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

e. To ensure long life, motors shall have nameplate horsepower [kW] equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp [kW]	Open	1.15
	Other Than Open	1.0
Integral hp [kW]	Open	1.15
	Other Than Open	1.0

Motors used with adjustable frequency drives shall have a 1.15 service factor on sine wave power and a 1.0 service factor on drive power.

f. Designed for full voltage starting.

g. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

h. Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

i. Bearings shall be either oil or grease lubricated.

j. Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

k. Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

l. Totally enclosed motors shall be furnished on:

   (1) Outdoor equipment.

   (2) Equipment for installation below grade.

   (3) Equipment operating in chemical feed and chemical handling locations.

   (4) Equipment operating in wet or dust-laden locations.

m. A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, the motor types indicated are preferred and shall be furnished if offered by the manufacturer as a standard option.

2-3. MANUFACTURE AND FABRICATION.

2-3.01. Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2-3.02. Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage in Concrete and Masonry section unless otherwise indicated on the Drawings.

2-3.03. Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2-3.04. Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer’s recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2-4. MATERIALS.

2-4.01. Mechanical Identification. Mechanical identification consisting of equipment number plates, equipment information plates, valve tags, and ductwork identification shall conform to the requirements of the Equipment and Valve Identification section and as indicated herein.

2-4.01.01. Number Plates. Hand-lettered or tape labels will not be acceptable.

Number plates for control equipment such as but not limited to thermostats, control stations, and emergency ventilation shutoff switches shall in addition to the specific device identification list the controlled equipment in parenthesis below the device number.

2-4.01.02. Piping. Piping identification shall be as specified in the Protective Coatings section. The lettering size, length of color field, colors, and viewing angles of identification devices shall be in accordance with ASME A13.1.

2-4.01.03. Valves. Not used.

2-4.01.04. Ductwork. Not used.

2-4.02. Seismic Design. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by the Engineer.

The installation of identifying devices shall be coordinated with the application of covering materials and painting where devices are applied to surfaces. All surfaces to receive adhesive number plates shall be cleaned before installation of the identification device.

End of Section

Section 15067

MISCELLANEOUS PLASTIC PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of miscellaneous plastic pipe, tubing, and accessories. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, jointing materials and other necessary appurtenances.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

Name of Manufacturer
Type and model
Construction materials, thickness, and finishes
Pressure and temperature ratings

Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

Pipe, tubing, and fittings shall be stored between 40°F and 90°F [4°C and 32°C].

PART 2 - PRODUCTS

2-1. FRP PIPE. Not used.

2-2. PVC PIPE MATERIALS. PVC pipe materials and services shall be as specified herein.

2-2.01. Material Classification PVC-1. Not used.

2-2.02. Material Classification PVC-2.

PVC-2 – Schedule 80 PVC Pipe with Solvent Welded Joints. HVAC condensate drain piping	Pipe Fittings	ASTM D1785, Cell Classification 12454, bearing NSF seal, Schedule 80. ASTM D2467, Cell Classification 12454, bearing NSF seal. Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld. When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.

2-2.03. Material Classification PVC-3. Not used.

2-2.04. Material Classification PVC-4. Not used.

2-2.05. Material Classification PVC-5. Not used.

2-2.06. Material Classification PVC-6. Not used.

2-2.07. Material Classification PVC-7. Not used.

2-2.08. Material Classification PVC-8. Not used.

2-2.09. Accessory Materials. Not Used.

2-3. CPVC PIPE. Not used.

2-4. PE PIPE. Not used.

2-5. POLYPROPYLENE PIPE. Not used.

2-6. PVDF PIPE. Not used.

2-7. REINFORCED PLASTIC TUBING. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Section 15070

COPPER TUBING AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of copper tubing and accessories. Copper tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

Name of Manufacturer
Type and model
Construction materials, thickness, and finishes
Pressure and temperature ratings

Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2-1. MATERIALS. Copper tubing materials and service shall be as specified herein.

2-1.01. Material Classification CU-1. Not used.

2-1.02. Material Classification CU-2. Not used.

2-1.03. Material Classification CU-3. Not used.

2-1.04. Material Classification CU-4. Not used.

2-1.05. Material Classification CU-5. Not used.

2-1.06. Material Classification CU-6. Not used.

2-1.07. Material Classification CU-7.

CU-7 – ARC Tubing with Brazed Fittings Refrigerant piping.	Tubing Fittings	Hard drawn ACR copper tubing, ASTM B280. Dimensions shall be in accordance with ASTM B280. Brazed.

2-1.08. Material Classification CU-8. Not used.

2-1.09. Accessory Materials. Accessory materials for the copper tubing systems shall be as indicated.

Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut.
Flange Gaskets	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch [3 mm] thick.
Expansion Joints	Tempflex "Model HB Expansion Compensators" with copper tube ends.
Insulating Fittings	
Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, poly-propylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Section 15650

REFRIGERATION SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of refrigerant piping and accessories, ductless split systems, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15. Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of Florida Building Code – Energy Conservation, unless otherwise indicated on the Drawings.

Capacity ratings for heat pumps with capacities less than 135,000 BTUH [39 kW] shall be in accordance with AHRI Standard 210/240. For heat pumps with capacities over 135,000 BTUH [39 kW] the capacity ratings shall be in accordance with AHRI Standard 340/360.

1-2.05. Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.

1-2.06. Metal Thickness. Metal thickness and gauges specified herein are minimum requirements. Gauges refer to US Standard gauge.

1-2.07. Mechanical Identification. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Refrigerant Piping

Schematic arrangement showing equipment, coils, piping sizes, valves, and accessories.

A refrigerant piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction.

Ductless Split System Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Location and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Multiline wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Where specified, information on equipment manufacturers' representatives.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1-4. QUALITY ASSURANCE. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-6. EXTRA MATERIALS. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and

encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

For equipment including fans, each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet [0.9 m] of clear access space shall be provided on all sides of the unit unless otherwise indicated.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. MATERIALS.

2-4.01. Refrigerant Piping and Accessories. Refrigerant piping shall conform to the Copper Tubing and Accessories section. Piping shall be supported as specified in the Pipe Supports section. Refrigerant filter dryers, expansion valves, solenoid valves, combination sight glass and moisture indicators, charging valves, relief valves, and other accessories shall be furnished and installed as needed for proper operation of the system.

2-5. EQUIPMENT.

2-5.01. Heat Pumps. Not used.

2-5.02. Room Air Conditioner. Not used.

2-5.03. Packaged Air Conditioning Units. Not used.

2-5.04. Ductless Split Systems. Ductless split systems shall be furnished and installed where indicated on the Drawings. Each system shall include indoor ceiling cassette fan coil units and an outdoor remote heat pump. Each system shall be fully charged with R-410A and compressor oil. A programmable thermostat shall be provided for control of each system.

Each fan coil unit shall consist of a fan, evaporator coil, air filter, return grille, supply louver, mounting harness, and drain pan. Air filters shall be of the cleanable type. Each unit shall be provided with access doors for easy removal of the filters. Fan coil units shall be 4-way ceiling cassette type with manufacturer provided disconnect switches, integral condensate lift mechanism, and multiple speed fan. Fan coil units shall be provided in capacity and quantity as indicated on the drawings.

Outdoor heat pumps shall be capable of supplying refrigerant to multiple fan coil units and be provided with inverter scroll compressors for modulation. Heat pumps shall be provided with manufacturer's twinning kit as necessary to meet capacity requirements, factory seacoast protection coating, and in capacity and quantity as indicated on the drawings.

Each heat pump shall be provided with touchscreen thermostat for control of heat pump and associated indoor fan coil units. Thermostat shall be capable of enabling and disabling heat pumps and fan coil units, user input of setpoint, display of system errors, and communication with VRF controller.

One VRF controller shall be provided that will communicate with all thermostats. VRF controller shall be capable of monitoring and controlling each heat pump and their associated fan coil units. VRF controller is responsible for balancing run time between systems and modifying lead/lag accordingly.

Ductless split systems and components shall be as manufactured by Trane/Mitsubishi, Daikin, or LG.

2-5.05. Water Chillers. Not used.

2-6. ELECTRICAL. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4X enclosures.

2-7. DRIVE UNITS. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2-8. MANUFACTURE AND FABRICATION. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2-9. SHOP TESTING. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2-10. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3-2. PREPARATION.

3-2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3-2.02. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of

top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3-3. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath the baseplate shall be grouted as specified in the Grouting section.

3-3.01. Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body and with the applicable requirements of the valve sections.

3-3.02. Refrigerant Piping and Accessories. The refrigerant piping shall be sized and arranged in accordance with the manufacturer's recommendations. Pipe routing and isolation shall be selected to minimize vibration and transmission of sound to the conditioned space. The refrigerant piping system shall be provided with the necessary traps and risers for uniform return of oil to the compressor. A piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction shall be submitted in accordance with the Submittals section.

3-3.03. Heat Pumps. Not Used.

3-3.04. Packaged Air Conditioning Units. Not used.

3-3.05. Ductless Split Systems. Ductless split systems shall be installed in accordance with the manufacturer’s installation instructions. Each unit shall be leveled and installed to maintain the recommended clearances.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. Where an installation check by the manufacturer is specified in the equipment installation paragraphs above, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section and shall revisit

the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3-4.02. Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable

3-4.03. Operator Instruction and Training. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

a. Documentation in the final Operation and Maintenance Manuals.
b. Use the Operation and Maintenance Manuals.
c. Equipment and system startup and shutdown.
d. System operation procedures for all modes of operation.
e. Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as required.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3-5. CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

Section 15990

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1-1. SCOPE. This section covers the cleaning, testing, adjusting, and balancing of the air system(s) associated with the heating, ventilating, and air conditioning (HVAC) systems.

1-2. GENERAL. Equipment and systems shall be cleaned, tested, adjusted, and balanced in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that all components and devices necessary for a properly functioning system have been provided. Prior to cleaning, testing, adjusting, and balancing, Contractor shall verify that each system has been installed properly and is operating as specified. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.

Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct mounted equipment, and control components.

1-2.02. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of air systems.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete apparatus report sheets for all air systems shall be accurately and completely filled out in accordance with the Standard's manual. The testing and balancing results shall be submitted on the TAB report forms of the applicable standard. Copies of the final test readings and report sheets shall be submitted in accordance with the Submittals Procedures section. A description of the standard procedures used during testing, adjusting, and balancing shall be included in the submittal. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report sheets. Test dates shall be recorded on the individual TAB report forms indicating when the actual testing was performed.

The apparatus report sheets shall include the following information:

1. Title Page:
    a. Company name
    b. Company address
    c. Company telephone number
    d. Project name
    e. Project location
    f. Project Engineer
    g. Project Contractor
    h. Project altitude
    i. Date
2. Instrument List:
    a. Instrument
    b. Manufacturer
    c. Model
    d. Serial number
    e. Range
    f. Calibration date
3. Air Moving Equipment:
    a . Unit number
    b. Location
    c. Manufacturer
    d. Model and serial number
    e. Airflow, design and actual
4. Electric Motors: Not used.
5. V-Belt Drive: Not used.
6. Return Air/Outside Air Data: Not used.
7. Coil Data:
    a. Unit number
    b. Location
    c. Service
    d. Manufacturer
    e. Airflow, design and actual
    f. Entering air DB temperature, design and actual
    g. Entering air WB temperature, design and actual
    h. Leaving air DB temperature, design and actual
    i. Leaving air WB temperature, design and actual
8. Duct Traverse: Not used.
9. Outlet and Inlet Devices: Not used.
10. Sound Level Report: Not used.
11. Package Air Conditioning/Heat Pump Unit. Not used.
12. Air Terminal Unit Data: Not used.
13. Electric Duct Heater: Not used.
14. Air Cooled Condenser/Heat Pump:

a. Unit number
b. Location
c. Manufacturer and model
d. Refrigerant type and capacity
e. Entering DB air temperature, design and actual
f. Leaving DB air temperature, design and actual
g. Number of compressors
h. Suction pressure and temperature
i. Condensing pressure and temperature

15. Chillers: Not used.
16. Pump Data: Not used.
17. Heat Exchanger: Not used.
18. Combustion Test: Not used.

1-4. QUALITY ASSURANCE. Contractor shall provide the services of a licensed independent contractor, certified by AABC, NEBB, or TABB and with proven experience on at least three similar projects, to perform operational testing, adjusting, and balancing of the air systems. The work shall be performed in accordance with the latest edition of the procedural standards as published by the National Organization associated with the testing, adjusting, and balancing contractor.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be adjusted or balanced to meet the specified conditions and to operate at the elevation indicated in the equipment sections.

2-2. CONSTRUCTION.

2-2.01. Painting. Surface finish damaged during cleaning, testing, adjusting, and balancing of equipment shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

PART 3 - EXECUTION

3-1. INSPECTION. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed. Fans shall be checked for correct rotation and rotative speed. Dampers shall be open and access doors and panels shall be closed during the testing and balancing period.

3-2. STARTUP REQUIREMENTS. System equipment shall be subject to preliminary field tests as indicated in Startup Requirements section.

3-3. FIELD PERFORMANCE TESTING. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and

to the satisfaction of Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to secure Engineer's acceptance of each system. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and tests shall be repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3-3.01. Hydronic Piping. Not used.

3-3.02. Refrigerant Piping. The refrigerant piping system shall be tested in accordance with ANSI/ASME B31.5.

After testing of the refrigerant piping system is completed, the system shall be charged with the proper refrigerant and placed in operation.

The completed refrigerant system shall be guaranteed to be sufficiently free from leaks for 1 year from the date of acceptance. The loss of refrigerant shall not exceed 5 percent over that period.

3-4. CLEANING. At the completion of the testing, all parts of the installation shall be thoroughly cleaned. All equipment, ductwork, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

3-4.01. Chemical Pipe Cleaning. Not used.

3-5. ADJUSTING & BALANCING. The air system shall be adjusted and balanced.

All instrumentation shall be calibrated in accordance with the governing standard manual and shall be checked for accuracy before testing, adjusting, and balancing the systems. The accuracy of the instrumentation shall be not less than specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.

All data, including system deficiencies encountered and corrective measures taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, Contractor shall notify Engineer in writing as soon as practicable.

All belt guards, panels, and doors removed during testing, adjusting, and balancing shall be reinstalled.

End of Section