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| **EDIT NOTE: THIS SECTION REQUIRES EDITING ON A PROJECT SPECIFIC BASIS.** |

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. Indoor and outdoor air handling units.

B. Related Requirements:

1. Division 01: General Requirements.

2. Section 23 05 00: Common Work Results for HVAC.

3. Section 23 05 13: Basic HVAC Materials and Methods.

4. Section 23 05 48: HVAC Sound, Vibration and Seismic Control.

5. Section 23 07 00: HVAC Insulation.

6. Section 23 09 00: HVAC Instrumentation and Controls.

7. Section 23 20 13: Above Ground HVAC Piping.

8. Section 23 20 16: Underground HVAC Piping.

9. Section 23 80 00: Heating, Ventilating and Air Conditioning Equipment.

**1.02 REFERENCES**

## A. Air Movement and Control Association International, Inc. (AMCA):

1. AMCA 211 – Certified Ratings Program - Product Rating Manual for Fan Air Performance.

2. AMCA 300 – [Reverberant Room Method for Sound Testing of Fans](http://cart.amca.org/publications/product.asp?PN=300/N).

3. AMCA 301 – [Methods for Calculating Fan Sound Ratings from Laboratory Test Data](http://cart.amca.org/publications/product.asp?PN=301/N).

B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

1. AHRI 410 – Forced Circulation Air-Cooling and Air-Heating Coils.

## C. American Society for Testing and Materials International (ASTM):

## 1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.

## 2. ASTM D2247 – Standard Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.

3. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

D. National Fire Protection Association (NFPA):

1. [NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems](http://www.nfpa.org/catalog/product.asp?pid=90A02&src=nfpa&order_src=A292).

E. Underwriters Laboratories, Inc. (UL):

1. UL 181 – Standard for Factory‑Made Air Ducts and Air Connectors.

2. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

3. UL 1995 –Heating and Cooling Equipment.

F. Underwriters Laboratories of Canada (ULC):

1. CAN/ULC-S102.2 – Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

G. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

1. ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality.

H. National Electrical Manufacturers Association (NEMA):

1. NEMA – MG 1, Table 12-10: NEMA Threshold Full-Load Nominal Efficiency Values for Energy-Efficient Motors.

**1.03 SUBMITTALS**

A. Comply with provisions of Division 01 and Section 23 0500: Common Work Results for HVAC.

B. Manufacturer's Data:

1. Complete materials list of items proposed to be furnished and installed under this Section. Materials lists, which do not require performance data, shall include manufacturer's name, type, and model number for indicated installation.

2. Manufacturer's specifications and other data required to demonstrate compliance with specified requirements. Literature shall include descriptions of equipment, types, models and sizes proposed, capacity tables or curves marked to indicate performance characteristics, electrical requirements, options selected, space requirements and other data necessary to ensure compliance with requirements of this Specification and performances indicated on Drawings.

3. Provide data of filter media, filter performance data, filter assembly, and filter frames.

C. Shop Drawings indicating methods of installation of equipment and materials, and details of supporting structures for items indicated. Items to be submitted shall include but not be limited to the following:

1. Layout Drawings of Equipment: Include plans, elevations, and sections, of proposed equipment drawn to scale, to establish which equipment shall fit in allotted spaces with clearance for installation and maintenance. Indicate proposed details for attachment. Indicate vibration isolation units, foundations, supports, and openings for passage of pipes and ducts.

2. Electrical interlock or control diagrams for electrically controlled components furnishing more than one automatic or manual control devices, which are not indicated on Drawings.

D. Manufacturer's Recommended Installation Procedures: Manufacturer's recommended installation procedures, when reviewed by the Architect shall become basis for inspecting actual installation procedures provided.

E. Acoustical Test Report: Submit complete acoustical test reports showing that proposed products have been tested in accordance with latest versions of AMCA Standard 300, [Reverberant Room Method for Sound Testing of Fans](http://cart.amca.org/publications/product.asp?PN=300/N), and AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

F. Submit test certification stating compliance with the maximum requirement of 1 percent cabinet leakage of the specified airflow.

G. Operations and Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts list and wiring diagrams.

**1.04 QUALITY ASSURANCE**

A. Qualifications of Manufacturers and Installers: Comply with provisions in Section 23 0500: Common Work Results for HVAC.

B. Sound Level Measurements and Calculations:

1. Sound power level measurements and calculations shall be made in complete accordance with latest version of AMCA Standard 300, [Methods for Calculating Fan Sound Ratings from Laboratory Test Data](http://cart.amca.org/publications/product.asp?PN=301/N), and AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

2. The results of all testing shall be certified by independent testing agency or an AMCA-approved testing laboratory and submitted to architect for approval. The submittal shall include a complete description of test conditions, methods and procedures, including specific installation type used for measurements, as detailed in AMCA 300.

3. Maximum Allowable Sound Power Levels: Maximum allowable sound power levels for supply discharge, return intake, and casing radiated noise shall not exceed values given in schedule below as indicated on drawings with equipment operating at design airflow and static pressure conditions.

C. Factory Leak Testing: Manufacturer shall provide a factory leak test on units at design total static pressure across the cabinet exterior walls. Cabinet leakage shall not exceed 1 percent of specified airflow on the operating side of the unit. All panels shall be sealed with closed cell gasketing material. A written test report shall be prepared by the manufacturer and submitted to the Architect.

**1.05 PROJECT RECORD DOCUMENTS**

A. Provide Owner instructions on equipment operation and maintenance procedures, as indicated in Section 23 0500: Common Work Results for HVAC.

**1.06 PRODUCT HANDLING**

A. Protection, Replacements, Delivery and Storage: Comply with provisions stated under Section 23 0500: Common Work Results for HVAC.

**1.07 COORDINATION**

A. Coordinate related and adjacent activities in accordance with provisions of Section 01 3113: Project Coordination.

**PART 2 – PRODUCTS**

**2.01 CUSTOM CENTRAL STATION AIR HANDLING UNIT (INDOOR OR OUTDOOR):**

A. General:

1. Central station air-handling unit specially designed, fabricated and factory tested for the capacity, configuration, arrangement and components as indicated on Drawings.

2. Units shall be UL or ETL approved to ensure compliance with electrical codes.

3. Unit shall be serviceable through service clearances indicated on drawings.

4. Unit dimensions shall not exceed dimensions indicated on drawings.

B. Base Frame: Provide a full perimeter welded base frame capable of mounting to a curb and supporting unit during shipment, installation, and operation. Base frame shall be manufactured with structural steel tubing or C-Channel support members. Formed metal base rails with bolted or screwed support members are not acceptable. Base and unit frame shall be painted with a gray phenolic, corrosion inhibitive primer. Base rails shall be fitted with lifting lugs at corner of unit or section (if demounted). Base rail shall overhang curb to facilitate water run-off and protection of curb-to-base connection from water intrusion. Base shall include a formed pocket that seats on roof curb gasketing to provide a positive, weather-tight seal.

C. Base: The base shall include 2-inch foam insulation or a 4-inch thick fiberglass insulated “double bottom” floor with minimum 20 gage G-90 galvanized outer and 14 gage G-90 galvanized inner walk-on surface. Subfloor is not required with 2-inch foam insulation unless the underfloor is being used as a return air plenum. All floor seams shall be sealed for an airtight unit. Where access is provided to unit interior, floor openings shall be covered with walk on steel safety grating. Single wall floors with glued and pined insulation are not acceptable. Base frame shall be attached to unit at factory.

D. Casing:

1. Sections of unit shall be of same construction and finish except for interior panels that are specified differently for individual sections.

2. Exterior Panels: Exterior panels including cooling coil sections shall be minimum 2-inch thick formed 16 gage galvanized steel. Provide necessary support to limit casing deflection to 1/200 of narrowest panel dimension. If panels cannot meet this deflection, add additional internal reinforcing. Panel seams shall be fully welded or sealed for an airtight unit. Leakage rates shall be less than 1 percent at design static pressure. The exterior panel finish shall have a polyurethene paint system that is designed for long term corrosion resistance meeting or exceeding ASTM B117, Salt Spray Resistance, at 95 degrees F, 1,000 hrs. and ASTM D2247, Humidity Resistance, at 95 degrees F, 1,000 hrs. The color shall be sterling gray.

3. Interior Panels: Casing shall be of double wall construction with 20 gage interior galvanized steel liner in all sections and 22 gage galvanized steel perforated liner in all fan sections.

4. Insulation: Casing shall have 2-inch minimum thickness fiberglass insulation with a density of not less than 3 pounds per cubic foot. The insulation shall have an effective thermal conductivity (C) of 0.24 BTU in./sq.ft.°F and a noise reduction coefficient (NRC) of 0.70 per inch thick (based on a type "A" mounting). Insulation and insulation adhesive shall be UL listed and shall meet NFPA 90A flame spread and smoke generation requirements. Insulation shall meet erosion requirements of UL 181 facing air stream and fire hazard classification of 25/50 (per ASTM E84 and UL 723 and CAN/ULC-S102.2). All insulation edges shall be encapsulated within exterior panel. Insulation facing air stream shall be provided with black acrylic coating.

5. Thermal Breaks: Casing construction downstream of the cooling coil shall consist of thermal break panels to prevent condensation from accumulating on outer walls

6. Access doors shall be of double wall construction and shall be installed on stainless steel hinges for outward opening applications. Multiple handles of no more than four, shall be provided to assure positive closure. Handles shall be zinc alloy or glass reinforced nylon and rated to meet 500 hour salt-spray requirements. Doors shall be furnished with 2 seals with an atmospheric break between two seals to ensure zero negative pressure. The outer seal shall shield water from inner seal. Doors shall open outward for negative pressure and inward for positive pressure applications. Operating pressure of unit shall ensure that door compresses gasket seal. Doors shall open against system pressure. Provide ETL, UL, and CAL/OSHA approved tool operated safety latch on all fan section access doors. Access doors downstream of the cooling coil shall be thermal break.

7. Roof for outdoor units shall be double wall, pitched away from motor side of unit at a minimum roof pitch of ¼ inch per foot across width of unit. No penetrations shall be permitted in pressure-sensitive panels. Roof shall incorporate a standing top seam. Seams in roof shall be gasketed and capped to prevent water infiltration into unit.

8. Floors shall be double wall. Insulation shall be capped to isolate floor insulation from both airstream and from potential water damage.

9. Units shall be provided with exterior paint.

10. Unit shall provide an integral base which is capable of curb, platform or pad mounting and supporting unit during shipment, installation, and operation.

11. Base shall overhang curb to facilitate water run-off and protection of curb-to-base connection from water intrusion.

12. Base shall include a formed pocket that seats on roof curb gasketing to provide a positive, weather-tight seal.

E. Fan Section:

1. General: Fan section shall be furnished with a structural steel base for integral mounting of fan assembly and casing panels. Fan scroll, wheel, shaft, bearings, drives, and motor shall be installed on a structural steel base frame assembly isolated from outer casing with factory-installed, spring isolators of deflection indicated on drawings. This base frame assembly shall be seismically braced. Flexible connectors shall be provided between fans and stationary part of unit. Wiring shall be in flexible conduit. Comply with Section 23 0548: HVAC Sound, Vibration and Seismic Control. Hinged access door, as specified above, shall be provided on both sides of unit.

2. Fans: Each unit shall be furnished with one or more supply fans as required. Fans shall be double-width, double-inlet type with backward curved airfoil blades or shall be single width, single inlet, ARR. 1 or ARR. 4 plug type fans with backward curved airfoil blades as indicated on equipment schedule. Fans shall be AMCA Class II rated.

3. Fan Bearings: Bearings shall be selected for a minimum L10 life (200,000 hours) at maximum horsepower and operating speed for classification. Bearings shall have same bore, type and manufacturer. Rigid support for inlet bearing must be removable for access to wheel.

4. Fan Wheels: Fan wheels shall be painted with zinc chromate primer and an enamel finish coat, unless constructed of aluminum. Fan wheels shall be keyed to shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected to operate at 25 percent below first critical speed, and shall be statically and dynamically balanced as an assembly at factory.

5. Fan shafts: Fan shafts shall be solid steel, turned, ground, polished, and coated with rust-preventive oil. Access doors shall be provided so fan shaft may be removed without removal of casing panels and to facilitate air balancing of system.

6. Fan Motor: The motor shall be installed within fan section casing on adjustable slide rails. Motor shall be open drip-proof, NEMA Design B with size and electrical characteristics as indicated on equipment schedule. Motors shall be mounted on a horizontal flat surface and shall not be supported by fan or its structural members. Each motor shall be tested to IEEE Standard 112, test method B, and NEMA MG 1 Article 12.58.2 and 12.59 Table 12-10 and bear a factory certification run test label to verify compliance. Motors shall be premium efficiency, inverter duty, with minimum 90 percent efficiency for motors greater than 3 horsepower.

7. Fan Drives: Fan drive shall be designed for a minimum 1.3 service factor, shall be constant-speed variable pitch for motors 15 hp or less, and shall be constant-speed fixed-pitch for 20 hp and larger. Drives shall be factory mounted, with belts aligned and tensioned.

8. Fan Sound Ratings: Fans shall be AMCA 211 rated for performance and AMCA 300 and 301 rated for sound.

9. Accessories: The fan section shall be furnished with double pane glass viewport with safety wire reinforcement, field wired service light with safety cage and extended lubrication lines to unit exterior for fan motor and fan bearings

F. Coil Section:

1. General: Coil sections shall be fabricated of insulated galvanized steel panels. Coils shall be easily removable from side of units. Where 2 or more coils are installed in a coil bank, 304 stainless steel intermediate drain pans that extend a minimum of 6 inches from coil face shall be provided and condensate shall be piped to bottom drain pan. The bottom coil shall not serve as a drain path for upper coil. Main drain pan shall be insulated double-wall 304 stainless steel, sloped toward drain fitting. Drain fitting shall be flush with bottom pan for side discharge, FPT 304 stainless steel connection and shall comply with ASHRAE Standard 62 recommendations. A maximum of one drain shall be furnished for each cooling coil section. Moisture shall not carry over past coil.

2. Coil Test and Standards: Coils shall be leak tested at 450 psig air pressure while submerged in water. Coil performance shall be certified in accordance with AHRI Standard 410. Coils shall be furnished with galvanized steel casing as standard.

3. Chilled Water Coils: Chilled water coils shall be aluminum sinusoidal plate fin type with belled collars and shall be bonded to 5/8 inch OD copper tubes by mechanical expansion. Coils shall be provided with headers for MPT or Victaulic connections. Working pressure shall be 300 psig at 200 degrees F. 0.008 inch thick aluminum-fin coils shall be provided with a wet-table finish to minimize water blow off. Coil casings and tube supports shall be 304 stainless steel. Coils shall be drainable and shall be provided with non-trapping circuits. Copper headers shall be provided with drain and vent connections external to unit.

4. Hot Water Coils: Hot water coils shall be 0.008 inch thick aluminum plate fin type with belled collars bonded to 5/8 inch OD Coils shall be provided with copper or red brass headers for MPT connections. Working pressures shall be 175 psig at 400 F. Headers shall be furnished with drain and vent connections external to unit.

5. Steam Distributing Coils: Steam distributing coils (non-freeze type) shall be 0.008” thick aluminum plate fin type with an outer copper tube diameter of 1 in. with a 5/8-inch diameter inner distributing tube and steel headers for MPT connections. Working pressure shall be 175 psig at 400 degrees F.

6. Coil Tubes: Tube wall thickness shall not be less than 0.02 inch. Tube diameter with 0.025 inch brazed return bends on water and refrigerant coils. Tubes shall be 5/8 inch OD to ensure high thermal performance with lower total flow and reduced pumping requirements. Intermediate tube support shall be provided for coils over 44-inch fin length with an additional support every 42 inches.

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a. Coil options shall be furnished with 0.008 inch thick copper fin construction.

7. Coil Piping Roof Penetrations: Roof curbs shall be rectangular without any offsets for coil piping to ensure a watertight roof connection. Coil piping which penetrates roof must be externally located from primary unit curb.

8. Roof curbs shall be rectangular without any offsets for coil piping to ensure a watertight roof connection. Coil piping which penetrates roof must be externally located from primary unit curb.

G. Filter Section:

1. General: Each filter section shall be designed and constructed to house specific type of filter indicated on equipment schedule. Provide filters of type indicated on schedule. A double-walled hinged access door, as specified above, shall be provided on side of section. Internal blank-offs shall be provided to prevent air bypass around filters.

2. Filter tracks in flat or cartridge filter sections: Filter tracks in flat or cartridge filter sections shall be upstream loaded Type 8 constructed from galvanized steel to ensure rigidity and tight tolerances. Tracks must be field adjustable without tools and designed to accept standard-size filters with one inch, 2-inch, or 4-inch widths.

3. Filter tracks in angle filter sections: Filter tracks in angle filter sections shall be constructed from galvanized steel to ensure rigidity and tight tolerances. Angle filter sections shall be designed to hold 2-inch filters of standard sizes, arranged in horizontal V-formation.

4. Bag or cartridge filter sections: Bag or cartridge filter sections shall be capable of accepting standard size 12-inch deep rigid media or bag filters. When bag/cartridge filters are installed in a positive pressure application, section shall be furnished with upstream service filter access and doors shall open inward against pressure for safety and leak integrity. For filters with lengths longer than 12 inches, additional plenum sections shall be furnished. Filter sizes shall be 24 by 24-inch or 12 by 24-inch only.

5. Each filter bank shall be provided with a Dwyer Series 2000 Magnehelic Differential Pressure Gage, or equal.

6. Mixing boxes or Economizer Section: Combination exhaust mixing boxes and filter-mixing boxes shall be furnished with opposed blades, interconnecting outside-air and return-air low leak dampers. Mixing boxes and filter-mixing boxes shall be furnished with a double-walled hinged access door as specified. Floors of 16 gage galvanized steel shall be furnished for mixing boxes to protect insulation during installation and servicing of damper actuators. Non-ducted outside air intakes shall include stationary louvers to reduce opportunity for rain or snow to enter unit.

H. Damper Section:

1. Face and bypass sections shall be furnished with opposed-acting damper blades in face damper and opposed bypass damper. Blades shall be double-skin airfoil type.

2. Damper blades shall be extruded aluminum, housed in a galvanized steel frame and mechanically fastened to a hex axle rod rotating in stainless steel bearings. Dampers shall be sectionalized to limit blade length to no more than 48 inches so as to minimize blade warpage. Replaceable neoprene blade seals are to be provided to insure tight closure.

3. Dampers shall be rated for maximum leakage rate per square foot of 7 cf. at 1.0 inch wg. Optional premium dampers shall be available for maximum leakage rate per square foot of 5 cfm at 1.0 inch wg. Damper blades shall be double-skin extruded aluminum airfoil type with stainless steel jam seals.

I. Plenum Sections:

1. General: Inlet, discharge, access, and plenum sections shall be installed where indicated on Drawings and shall be as specified on equipment schedule.

2. Inlet section: Inlet section shall be provided with extruded aluminum stationary louvers. Louvers shall be drainable type with built in downspouts and furnished with birdscreen. Blades shall be vertical and housed inside an aluminum frame and mounted to unit exterior. Louvers shall be painted to match unit exterior.

3. Access sections: Access sections shall be provided by a double-walled hinged door, as specified above and 16 gage galvanized steel floors to protect insulation.

4. Downblast discharge section: Downblast discharge section, which provides an opening through roof, shall be furnished with a grating over duct opening of sufficient size and strength to support a minimum of 300 pounds.

5. Diffuser sections: Diffuser sections shall consist of casings as specified with an integral perforated aluminum plate installed on discharge side of supply fan to ensure even and uniform air distribution over adjacent downstream component. Not required on plug fan applications.

a. Blow-thru coil sections shall be provided with diffuser as an integral part of coil section and shall not extend length of standard section.

b. Diffuser sections shall be available and required if a filter section is directly following fan.

c. Unit panels shall be constructed of 16 gage galvanized steel.

d. A hinged access door shall be provided down-stream of mixer if specified. It shall be full height, insulated double-wall, with full perimeter gasketing.

e. Unit shall mix two or more air streams of different temperatures to within a range of six degrees F standard deviation of theoretical mixed-air temperature and shall provide a more uniform air velocity contour entering a downstream filter or coil bank.

J. Sound Attenuators: Sound attenuators as specified in Section 23 0548 shall be provided as an integral part of unit when specified or indicated on drawings.

K. Electrical: Provide electrical and automatic control devices that are listed below and on drawings:

1. The units shall be factory pre-wired for a single point electrical power connection for both power and control circuits. Manufacturer shall provide a factory furnished and wired step down transformer with a fused disconnect for 120 Volt service.

2. Provide a main disconnect for each unit.

3. Each fan motor shall be wired to a non-fusible disconnect.

4. The unit shall be equipped with vapor proof light fixtures with guard.

5. Lights shall be controlled by one light switch mounted adjacent to supply air fan access door. Lights shall be provided in each accessible section.

6. Furnish a 120 Volt duplex convenience outlet on exterior of unit. Locate outlet next to fan section access door.

7. A separate Variable Frequency Drive and three contactor bypass is required for each motor in unit including factory mounting and wired to motor. Danfoss, ABB, Toshiba, or equal.

8. VFDs shall be recessed or surface mounted as shown on the drawings.

L. Acoustical Performance Requirements: The sound generating characteristics of air handling and multi-zone units shall be tested to, and comply with, all requirements of this specification. Representative samples shall be subjected to tests in accordance with applicable standards and procedures in order to demonstrate such compliance. A special test for this project is not required if manufacturer has previous certified test results that can be made applicable to this project.

M. Manufacturer: Carrier or Trane.

**PART 3 – EXECUTION**

**3.01 GENERAL**

A. Examine areas under which Work of this Section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

**3.02 EQUIPMENT FOUNDATIONS**

A. Equipment foundations shall be of sufficient size and weight, and of proper design to preclude shifting of equipment under operating conditions, or under any abnormal conditions imposed upon equipment.

B. Foundations shall meet requirements of equipment manufacturer and, when required by the Architect, obtain from equipment manufacturer, approval of foundation design and construction for equipment to be installed. Equipment vibration shall be maintained within design limits, and shall be dampened and isolated. Isolators shall be bolted to a steel member so as to be readily removable.

**3.03 EQUIPMENT INSTALLATION**

A. Equipment Installation: Equipment installation shall be in strict accordance with these Specifications, and installation instructions of manufacturers. Equipment installed on concrete foundations shall be grouted before piping is installed. Piping shall be installed in such a manner as not to place a strain on any of the equipment. Flanged joints shall be adequately extended before installation.

1. Install equipment in a neat and skillful manner, properly aligned, leveled, and adjusted for satisfactory operation.

2. Install so connecting and disconnecting of piping and accessories can be readily accomplished, parts are readily accessible for inspection, service and repair. Space shall be provided to readily remove filters, coils, and fan wheels.

**3.04 NOISE AND VIBRATION**

A. Operation of Equipment: Mechanical equipment and piping systems shall operate without exceeding specified noise and/or vibration levels.

B. Corrective Measures: If specified noise and/or vibration levels are exceeded, provide necessary changes to reduce noise and/or vibration levels to within specified levels.

**3.05 FIELD TESTS AND INSPECTION**

A. General: Perform field inspections, field tests, and trial operations as specified in Section 23 0500: Common Work Results for HVAC. Provide labor, equipment and incidentals required for testing. The Project Inspector will witness field tests and trial operations as specified in Section 23 0500: Common Work Results for HVAC.

B. Equipment and Material: Equipment and material certified as being successfully tested by manufacturer, in accordance with referenced Specifications and standards, will not require re-testing before installation. Equipment and materials not tested at the place of manufacture will be tested before or after installation, as applicable or necessary, to determine compliance with reference Specifications and standards.

C. Start-Up and Operational Test: System shall be started up and initially operated with components operating. During this test, filters shall be periodically cleaned until no further accumulation of foreign material occurs. Adjust safety and automatic control instruments as required to provide proper operation and control sequence. Refer to Section 23 0500: Common Work Results for HVAC.

D. Extent of Field Tests: After installation and before completion, Work of this Section shall be subjected to required field tests, including those specified here and in Section 23 0500: Common Work Results for HVAC.

E. Operation and Maintenance Data: Provide required operation and maintenance data as specified in Section 23 0500: Common Work Results for HVAC.

**3.06 PROTECTION**

A. Protect the Work of this Section until Substantial Completion.

**3.07 CLEANUP**

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION