

PART 1 GENERAL**1.1 RELATED DOCUMENTS**

- A. The requirements of the General Conditions, Supplementary Conditions and the following Specification sections apply to all Work herein:
1. Section 23 00 10 - General Requirements
 2. Section 23 00 20 - HVAC Scope of Work
 3. Section 23 05 07 - Design Conditions
 4. Section 23 05 13 - Motor Requirements for HVAC Equipment
 5. Section 23 05 30 - Miscellaneous Equipment
 6. Section 23 05 48 - Vibration Isolation
 7. Section 23 05 93 - Testing, Balancing and Adjusting
 8. Section 23 31 00 - Ductwork and Sheet Metal
 9. Section 23 40 00 - Air Filtering

1.2 SUMMARY

- A. Furnish and install all factory-built air handling units herein specified and as indicated on the Drawings.

1.3 REFERENCE STANDARDS

- A. All factory built air handling units and accessories shall be designed, manufactured and tested in accordance with the latest applicable industry standards including the following:
1. ASTM B-88-72 H23.1-59, E84, C423-90a and E795-83
 2. NFPA 90A, 90B and 255
 3. UL 723
 4. AHRI Standard 410
 5. Mechanical Power Transmission Association and the Rubber Manufacturers Association, Inc. – "Engineering Standards for Multiple V-Belt Drives - 1972"
 6. AMCA 210-85, 211, 300 and 311
 7. ISO BS-848-1980 and 1940 G6.3
 8. IEEE 444 and 519-1992
 9. NEMA ICS-3-303
- B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authorities Having Jurisdiction and suitable for its intended use on this Project.

1.4 SUBMITTALS

- A. The following submittal data shall be furnished according to the General Conditions and Section 23 00 10 and shall include, but not be limited to:
1. Custom Factory-Built Air Handling Units* complete with fan and coil selection data, calculations, physical dimensions, horsepower and starting requirements, VFD drives, motor details, etc. Shop Drawings shall indicate specifically that the construction, fabrication, etc., of the units to be furnished complies with these Specifications.
 2. Variable Speed Drives* complete with enclosure construction details, line reactor or tuned filter data, design features, accessories, disconnect, capacitor, mechanical bypass, if specified, and spare parts data.
 3. Acoustical and Performance Mock-Up Test Details complete with mock-up drawings and description of scope of work. Indicate air handling unit lead time required, coordination requirements with Division 25, and name and location of the laboratory conducting the testing for approved by the Owner.
 4. Coil pressure test logs listing the air handling unit coils tested, date of test, pressure at start of each test, pressure at the end of each test, duration time for the test and the name of the test supervisor for each test.
 5. Factory fan balancing certifications.

6. Prior to execution of factory testing and lab testing, submit test procedures, recording forms, and test equipment cut sheets to Engineer for review. Refer to Section 23 00 20 titled "Scope of Work" for "Scheduling Procedures".
 7. Factory Test Schedule.
 8. Factory Test Reports.
 9. Lab Test Schedule.
 10. Lab Test Reports.
 11. One (1) spare motor and fan assembly or FWT fan "cartridge" of each size supplied for Owner stock.
- B. All items or equipment listed above with asterisks (*) shall be certified by the manufacturer using Manufacturer Certification "MCA" as set forth in Section 23 00 10. See Section 23 00 10 for certification requirements.

1.5 WARRANTY

- A. Comply with the requirements of the General Conditions and Section 23 00 10.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. If it complies with these Specifications, custom factory built centrifugal fan type air handling units manufactured by one of the following manufacturers will be acceptable:
1. Carrier / Racan
 2. CES Group / Temtrol
 3. ClimateCraft, Inc.
 4. Haakon Industries
 5. Trane / Air Systems
 6. York / Custom
- B. If it complies with these Specifications, fans manufactured by one of the following manufacturers will be acceptable:
1. Acme
 2. Buffalo Fan
 3. Carrier
 4. Greenheck
 5. Huntair
 6. Loren Cook
 7. Trane
 8. Twin City Fan
- C. If it complies with these Specifications, fan sheaves manufactured by one of the following manufacturers will be acceptable:
1. Browning
 2. Eaton Yale and Towne
 3. Dodge Manufacturing Company
 4. Fort Worth Steel and Machinery Company
 5. T. B. Woods
- D. If it complies with these Specifications, belts manufactured by one of the following manufacturers will be acceptable:
1. Gates
 2. Durkee-Atwood.
 3. Goodyear.
 4. Uniroyal
 5. Browning
- E. If it complies with these Specifications, water coils manufactured by one of the following manufacturers will be acceptable:
1. Aerofin

2. Carrier
 3. CES Group
 4. ClimateCraft, Inc.
 5. Heatcraft
 6. Trane
 7. York
- F. If it complies with these Specifications, electric heating coils manufactured by one of the following manufacturers will be acceptable:
1. Brasch
 2. Chromalox
 3. Harver
 4. Indeeco
 5. Market Products
 6. Tutco

2.2 CUSTOM FACTORY-BUILT CUSTOM AIR HANDLING UNITS

- A. General:
1. Custom factory-built air handling units shall be horizontal draw through or blow through type with fan and coil requirements and capacities as listed in the schedules on the Contract Documents. Refer to the drawings for air handling unit configurations.
 2. Unless otherwise noted, each air handling unit shall be complete with air handling unit casings, centrifugal plenum wheel fans, discharge plenum casing with ductwork connections as indicated on the Drawings, return air plenum casing as shown on the drawings, internal spring type vibration isolation, insulation, stainless steel drain pans, heating coils, cooling coils, casing section for air filters or electronic air cleaners as specified in Section 23 40 00 titled "Air Filtering" and in the schedules on the Contract Documents, fan motors with adjustable bases, belt guards, belt drives, and variable speed drive controllers. Coordinate requirements with the Division 25 Subcontractor. The units shall comply with the following minimum requirements.
 3. Sound Ratings:
 - a. Each air handling unit shall be constructed and shall operate for all conditions of air flow (including full load to thirty (30%) percent full load air flow for each unit serving variable air volume systems) to provide an NC environment in the occupied tenant space as specified in Section 23 05 07 titled "Design Conditions", except these units shall not produce higher than an NC 40 within 6' from the air handling unit room wall adjacent the tenant space. Sound ratings shall be achieved adjacent to the air handling unit room in occupied Tenant areas with the discharge ductwork from the unit constructed as per the Drawings and Specifications. Sound rating required for the completed installation shall be achieved with the air handling unit designed, constructed and installed to comply with the sound criteria listed herein with the room construction as indicated on the Architectural and Structural Drawings for this Project and with the ductwork and vibration isolation as indicated in these Specifications and on the Mechanical Drawings.
 - b. The air handling unit manufacturer shall conduct testing in a laboratory approved by the Owner to demonstrate the acoustical performance of the air handling unit in a mock-up similar to Project's typical floor air-handling unit fan room, approximately 15' wide x 20' long with a two (2) 15' x 15' tenant offices constructed immediately adjacent to the air handling unit room. Refer to Architectural Drawings for exact configuration and wall construction. The air handling unit manufacturer shall include the costs for the Project Acoustical Consultant to coordinate and witness the tests. The mock-up facility shall include, but not be limited to, the Project's supply air ductwork configuration within the air handling unit room, return air provisions from the mock-up office to the equipment room, Project mechanical fan room partition, standard tenant high ceiling, typical ceiling plenum depth above tenant office, Project's lighting fixtures, Project's office floor treatment, etc. The acoustical measurements shall be made in the mockup tenant office and outside the air handling unit room wall at various locations selected by the Owner with a 1/3 octave band or octave band analyzer and with the unit operating at one hundred (100%) percent, seventy-five (75%) percent, fifty (50%) percent, thirty-five (35%) percent, and twenty (20%) percent of design air flow capacity. If the air handling unit manufacturer has conducted the hereinbefore specified acoustical mock-up tests with this Project's typical conditions with a unit of similar capacity and horsepower in an Owner approved laboratory and has demonstrated to the Engineer and Owner compliance with this Project's specified acoustical performance, the previous acoustical laboratory testing will be

accepted and the testing will not need to be repeated. Test documentation shall be included with the equipment submittals.

4. Unit Casings:
 - a. Each unit shall have an airtight sectionalized casing constructed of "lock forming" quality galvanized steel, phosphatized steel or bonderized steel. Galvanized metal will not require painting. Phosphatized or bonderized metal shall be finished with rust-inhibiting paint. Air handling unit casings shall be minimum 3" thick double wall construction with a 16 gauge galvanized outer sheet and 22 gauge galvanized inner perforated sheet with twenty-five (25%) percent openings in all casing sections except the coil section. All casing sections for outside air pretreating units shall be fabricated thermal breaks and gasketed screws to prevent condensation formation on the outside of the air handling unit.
 - b. The casing section interior panels in the cooling coil section shall be 20 gauge stainless steel. The air handling unit shall consist of a discharge plenum fan section, a coil section or sections, a filter section and a 3" or 4" thick return air or mixing plenum casing section with control dampers where indicated on the Drawings. Suitable gaskets shall be provided at all joints between casing sections downstream of the fan unless the casing sections have welded seams. Stiffeners shall be provided, to prevent unit casing pulsation.
 - c. The air handling unit floor shall be minimum 10 gauge galvanized or painted walking surface with continuously-welded seams, stitch-welded to the base frame, and all wall panels continuously caulked or sealed with EPDM gaskets, and a minimum 20 gauge galvanized steel underliner filled with 3 lb. density acoustical insulation or foam insulation. Each air handling unit shall be designed and factory mounted on 8" high structural steel base with fully welded joints fabricated from 8" high perimeter channel. The air handling unit casing shall not exceed the maximum width shown on the Drawings.
 - d. Coil frame shall completely enclose all connections, coil headers and return bends. Coil frames shall not be used as structural members of the coil section. The entire channel coil frame support shall be stainless steel. The coil section shall be constructed in such a manner that the coils can be removed without affecting the structural integrity of the casing.
 - e. Access doors on the air handling unit shall be a minimum 24" wide by 60" high by 4" thick unless the unit size dictates a smaller door. The access door shall open against static pressure. The access door shall be hinged and allow for access to the fan, coil, filter and fan discharge section. The access doors shall be located so that the unit may be entered from the coil piping and access side of the unit, regardless of the mounting arrangement. Doors shall be double wall construction with 16 gauge galvanized steel on the outer panel and 20 gauge galvanized steel on the inner panel with minimum 4" thick 3 lb. fiber glass insulation or 2-1/4 lb. polyurethane insulation. Hinges shall be continuous and constructed of stainless steel. Provide access door handles, which are operable from both sides. Access doors shall have single or double gaskets and at least one handle per door equipped with a pad locking feature. All unit nameplates shall be mounted on the fan compartment access door.
 - f. The air handling unit casing shall be supplied with a minimum 3" thick factory double wall discharge plenum at the top of the air handling unit. The discharge plenum shall be integral or shall bolt to discharge side of the air handling unit and shall be gasketed at the joints. The discharge plenum shall have the same width as the unit casing. Height of the factory discharge plenum shall extend vertically as required to accommodate the discharge ductwork configuration indicated on the Drawings. The casing shall extend from the unit fan a minimum of 36" horizontally or one fan diameter from the discharge of the plenum fan. If a bottom outlet discharge section is indicated on the Drawings, it shall have an internal low pressure drop sound attenuators as scheduled. The entire unit shall be factory mounted on an 8" high structural base. The plenum height will be such that no additional height increase will be required to bolt the plenum to the air handling unit casing. The perforated inner sheet of the discharge plenum shall be minimum twenty-five (25%) percent open.
 - g. A factory installed return or mixed air plenum casing shall be provided on the air inlet to the unit. The return air casing shall be 3" or 4" thick double wall construction with sound insulation as specified for the unit casing. The perforated inner sheet of the return air plenum shall be minimum twenty-five (25%) percent open. The return air opening shall be on the access side of the unit and opening shall be sized such that the intake velocity through the opening does not exceed an air velocity of 1,000 fpm. The opening and return plenum shall be arranged to allow air filter replacement from the return air plenum.
 - h. The entire air handling unit, including the discharge plenum and fan discharge section, and the return air plenum insulation shall be 3" or 4" thick with 3 lb. density acoustical insulation, non-combustible, vermin and odor-proof, mildew resistant type between the double metal walls. All acoustical insulation under the twenty-five (25%) open perforated inner sheet shall have a Mylar or

FSK facing (foil/scrim/kraft). No exposed fiber glass will be allowed. All insulation within the air handling unit shall have a composite (insulation, facing and adhesive) fire and smoke hazard rating as tested by Procedure ASTM E84, NFPA 90A and UL 723 not exceeding:

- 1) Flame Spread 25
- 2) Smoke Developed 50

Accessories, such as adhesives, mastics and cements, shall have the same component ratings listed above. All insulation materials together with adhesives and finishes to be used on the Project shall be certified in writing to comply with the above criteria. See Section 23 00 10 for certification requirements

5. Internal Piping:

- a. The air handling manufacturer shall provide factory installed chilled water piping, individual coil full port ball type balancing valves with memory stops and no extended handles located on the individual return coil connection only and test plugs, completely within the air handling unit casing. At the air handling unit manufacturer's option, Griswold Quickset or Flow Design ball valves with flow optimizer and integral test plugs may be furnished. The factory installed piping shall exit the unit at the top. Piping escutcheon plates shall be installed on the inside of the unit and on the exterior at all coil piping penetrations. The automatic control valve will be furnished by Division 25 to the Division 23 Subcontractor for field installation in the piping outside of the air handling unit. The stop valves for the unit shall be field installed by the Division 23 Subcontractor outside the unit. Piping internal to the unit shall be ASTM B-88-72H23.1-59 Type "L" or Type "K" hand drawn pipe. All piping and fittings shall be suitable for the working pressure shown on the Contract Documents. The internal piping shall be sized to limit the velocity to no more than 5 fps at maximum design flow.
- b. All internal coil piping not installed over the drain pan shall be insulated with minimum 1/2" thick Armstrong Type AP or Rubatex R-180-FS 25/50 flexible elastomer pipe insulation with foil facing. Insulation shall have a fire and smoke hazard rating as tested by ASTM E 84 and UL-723 not exceeding: Frame spread 25 and smoke developed 50. The individual components shall comply with the requirements specified in Section 23 21 13 titled "Pipe, Valves, Fittings and Accessories".
- c. Internal copper piping shall be terminated at the top of the unit unless otherwise indicated on the drawings. Piping shall be terminated outside the unit with a threaded, flanged or grooved connection and an air seal device. Provide labels for the coil inlet and outlet connections on the exterior of the unit. Before each air handling unit is shipped from the factory all factory piping shall be hydrostatically or air pressure leak tested. The test pressure shall be as specified hereinafter.
- d. The factory hydrostatic or air pressure test shall be continuously maintained for a minimum of two (2) hours after which each piping joint, connection, etc., shall be examined to verify there is no evidence of weeping or leakage. The air handling unit manufacturer shall maintain a pressure test log listing the air handling unit tested, date of test, pressure at start of test, pressure at the end of the test, duration time for the test and the name of the test supervisor for each test. If liquid was used for the pressure testing, it shall be completely drained and blown out of all coils and the internal piping system prior to shipment. The factory test log shall be submitted to the Engineer and Owner for record prior to installation of the air handling units at the Project Site.

6. Electrical:

- a. The air handling unit manufacturer shall factory pre-wire the internal lights and switch, receptacles, electric heating coil contactor and all heating coil control panels, electronic air cleaners, ultraviolet lights, etc., for a complete pre-wired package.
- b. The air handling unit manufacturer shall provide an NEC code sized conduit raceway from the motor through the unit casing at least 2" which is capped for extension by the Division 26 electrical subcontractor. The Division 26 electrical subcontractor shall provide all wiring from the motor terminal to the motor controller. The air handling unit power wiring, except the motor wiring, (460 volt and 120 volt) and the control wiring shall terminate in a NEMA 1 enclosure terminal panels with tagged terminal strips. See Division 25 specifications for additional installation requirements. The air handling unit discharge temperature sensor will be provided and installed in the external ductwork by the Division 25 BMCS Contractor.
- c. The air handling unit manufacturer shall factory pre-wire an industrial quality vapor tight light fixture in the fan section only of the typical floor unit and in the fan section, coil section, heating coil section, filter section of all outside and other specialized units with an external switch and a separate pilot light or lighted toggle switch, near the access door and shall pre-wire a 120V ground fault circuit interrupting convenience receptacle outside the fan section. If the air handling unit is equipped with UVc ultraviolet lights, install a push-in type relay wired such that power to the UVc lights will be disconnected when the unit compartment lights are in the ON position. The entire air handling unit as assembled at the factory shall be UL or ETL labeled.

7. Drain Pans:

- a. The main drain pan shall extend under each complete coil section and shall be rigid and watertight with a 1-1/4" stainless steel pipe drain connection on the coil piping connection side. Intermediate drain pans shall extend at least 8" beyond the leaving side of the chilled water coil. The main drain pan shall extend the full distance from the coil support to the next component wall. If the distance from the coil support to the next component wall exceeds 52" the main drain pan shall extend at least 12" beyond the leaving side of the coil. The main drain pan and all intermediate drain pans shall be of dual slope design within the unit as required to allow each drain pan to drain completely dry upon unit shutdown when the air handling unit is installed on a level surface.
 - b. The intermediate drain pans shall have 1/4" thick foil faced Armstrong AP Armaflex elastomer insulation installed on the bottom of the pan. The drain pans shall be minimum 16 gauge stainless steel construction with continuously welded corners and joints. The exterior of the main drain pan shall be covered with minimum 1" thick 1.5 lb. density insulation. The main drain pan insulation shall be covered with 20 gauge galvanized metal. Stainless steel drain pans installed on top of an insulated bottom casing panel do not require insulation.
 - c. The main drain pan and all intermediate drain pans shall be graded within the unit as required to allow the drain pan to drain completely dry on unit shutdown. Intermediate drain pan drain piping shall be anchored and terminate three (3) inches above the lower main drain pan to allow for cleaning. If the air handling unit as installed in the field is not graded to permit complete condensate drainage, the entire unit must be shimmed by the mechanical contractor as specified hereinafter. The fan section shall have a minimum 1-1/4" threaded drain connection plugged at the factory for removal of condensate or water, which may collect in the fan section. The Mechanical Subcontractor shall shim the air handling unit channel base with Shear-flex pads as required to level the unit or to provide a slope of the drain pan toward the drain point of 1/16" per 1'-0" if required by the unit design to cause the drain pan to drain completely dry on unit shutdown.
8. Fans, Shafts and Drives:
- a. All fans shall be centrifugal unhooused belt drive plenum fans with single thickness airfoil backward curved aluminum wheels with aluminum inlet flow ring and belt drives or a multiple fan array of direct drive, Arrangement 4 plenum fans. Fan wheel shall be a plenum type fan wheel manufactured by Acme, Buffalo Fan, Greenheck, Loren Cook, Twin City Fan or approved equal. The fan motor location on the factory structural frame shall be top or side mounting. Fans shall be licensed to bear the AMCA seal. All metal parts of the fan framework shall be galvanized or cleaned and painted with UVc resistant enamel primer and finish coat. All metal parts of the fan framework shall be galvanized or cleaned and painted with UVc resistant enamel primer and finish coat. In order to establish fan test curves, each type of fan shall be tested in an AMCA certified laboratory in accordance with referenced AMCA Standards. Certified unit test curves shall be submitted by the unit manufacturer for review by the Engineer. Acoustical testing shall be in accordance with AMCA 300. Acoustical test data for the fan shall be submitted to the Engineer for review.
 - b. Centrifugal Unhooused Plenum Fans:
 - 1) Fans, sheaves, motors, belts and vibration isolation shall be factory assembled within the fan section casing. The air handling unit manufacturer shall supply balanced fans, motors and sheaves. Air handling unit fans, bearings and fan sheaves shall be balanced to a maximum of 1.5 mil peak-to-peak on the horizontal and vertical plane as measured at the fan mounting leg. Balancing shall be to a maximum of 5 mil peak-to-peak in the axial direction at the fan rotational frequency and shall be measured adjacent to the fan inlet end bearing. Matched components shall be factory balanced continuous twenty-five to one hundred (25 - 100%) percent rpm. Factory balancing data shall be so certified in writing by the manufacturer to the Engineer. Should the air handling unit develop vibration and/or balance problems after installation and prior to the expiration of the guarantee period, in the sole opinion of the Engineer or Owner, the unit manufacturer or an independent testing agency shall perform a field balancing test using a portable IRD (or approved equal) to verify compliance with the hereinbefore specified balancing requirements. See Section 23 05 93 titled "Testing, Balancing and Adjusting". The air handling unit manufacturer shall replace all components that cannot meet these balance and vibration requirements without additional cost to the Owner.
 - 2) Fan drives shall be selected with a minimum belt horse-power capacity of one hundred and fifty (150%) percent of the motor nameplate horsepower. All typical air handling units of the same size shall have identical drive assemblies; motor sheaves, fan sheaves, and belts shall all be the same. All drives shall conform to industry standard tolerances as set forth in "Engineering Standards for Multiple V-Belt Drives - 1972" as adopted by the Mechanical Power Transmission Association and the Rubber Manufacturers Association, Inc. The selection calculations shall include the correction factor for arc of contact. The fan drive components shall be as follows:

- a) The motor sheaves shall be non-adjustable type selected for the rated fan rpm as determined by the fan requirements scheduled. Fixed sheaves shall be one of the manufacturers listed for the fan sheaves.
 - b) The fan sheaves shall be non-adjustable type with removable machined bushings. The sheaves shall be machined on all contact surfaces. Fan sheaves with over three grooves shall be dynamically balanced and the manufacturer shall emboss the legend "dynamically balanced" on each sheaves. Fan sheaves with three grooves or less shall be statically balanced. If weights are required for balancing, they shall be welded to the sheaves.
 - c) The belts shall be standard "V-Groove" Type suitable for the service intended with the capacities specified hereinbefore. The belts shall be closely matched and tagged prior to shipment. If in the opinion of the Engineer, the belts do not appear to be properly matched during operation, they shall be rechecked and, if necessary, replaced with another closely matched set of belts.
 - d) Belt guards are not required.
- 3) The fan shafts shall have SKF, Sealmaster, Timken, Fag, Fafnir externally or internally mounted grease lubricated self-aligning ball bearings on each end of the shaft. Bearings shall have a minimum life of L50-200,000 hours at design operating conditions. Extended grease piping shall not be installed. Life lubricated sealed bearings will not be acceptable.
 - 4) The unhooded fan wheel shall be all welded aluminum or tabbed aluminum construction with radially projected blades and engineered cross sections. All wheels shall be dynamically balanced and have a non-leading characteristic.
 - 5) The fan shaft shall be solid AISI-C1040 hot rolled steel, turned and polished. Close tolerances shall be maintained where shaft makes contact with the bearings. Fans shall not be cantilevered. Fans shall not pass through their first critical speed as the unit comes up to the rated rpm.
 - 6) Fan and motor assembly shall be internally isolated from the air handling unit casing with spring isolators. Spring isolators shall be located to prevent corrosion from condensation in the drain pan. See Section 23 05 48 titled "Vibration Isolation" for isolator requirements. Internal vibration isolators shall be sized for 2" static deflection and shall be a non-housed spring isolator unless seismic requirements are specified.
- c. Fan Arrays:
 - 1) Fan arrays shall have standard pedestal mounted type TEFC or TEAO T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified in Section 23 05 13 titled "Motor Requirements for HVAC Equipment". Fans shall be licensed to bear the AMCA seal. Fans, motors, and acoustic silencer modules shall be factory assembled within the fan section casings.
 - 2) The fan array shall be provided with integral acoustical silencers that reduce the bare fan discharge sound power levels as required to achieve the Project required fan intake and discharge sound power levels. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the air handling unit when compared to the same multiple fan array style unit without the integral silencers.
 - 3) Each fan/motor assembly shall be dynamically balanced to meet AMCA Standard 204-96, category BV-5, to meet or exceed Grade 1.0 residual unbalance. Factory fan balancing data shall be so certified in writing by the manufacturer to the Engineer. Should the air handling unit develop vibration and/or balance problems after installation and prior to the expiration of the guarantee period, in the sole opinion of the Engineer or Owner, the unit manufacturer or an independent testing agency shall perform a field balancing test using a portable IRD (or approved equal) to verify compliance with the hereinbefore specified balancing requirements. See Section 23 05 93 titled "Testing, Balancing and Adjusting". The air handling unit manufacturer shall replace all components that cannot meet these balance and vibration requirements without additional cost to the Owner.
 - d. Motors for belt driven fans shall be factory mounted directly on the fan framework, internal to the unit. All belt drive motors shall be one (1) speed, one (1) winding, unless indicated otherwise in the schedules on the Contract Documents. The motor shall operate at a maximum speed of 1800 rpm. Each motor shall be mounted to an adjustable base rigidly supported to the fan structural framework. Motor shall have an extended shaft to accommodate the fixed pitch motor sheaves specified herein. Refer to Section 23 05 13 titled "Motor Requirements for HVAC Equipment" for additional requirements.
 - e. Motors for direct drive multiple fan arrays shall be TEFC or TEAO factory mounted directly on the fan framework, internal to the unit. All motors shall be one (1) speed, one (1) winding, 4-pole (1,800 RPM Synchronous Speed), unless indicated otherwise in the schedules on the Contract Documents. The fan/motor assemblies shall be selected to operate at a maximum of 3,600 RPM

and 120 Hz. Refer to Section 23 05 13 titled "Motor Requirements for HVAC Equipment" for additional requirements.

- f. Variable Speed Fan Drive Controllers: Variable speed drives shall be provided for all fans as required in the schedules on the Contract Documents and Section 23 05 13. Refer to Section 23 05 13 titled "Motor Requirements for HVAC Equipment".
9. Chilled Water Coils:
- a. Coils shall be constructed with copper tubes and aluminum plate fins. Supply and return connections shall be on the same end of the coil. Fins shall be bonded to the tubes by means of mechanical expansion of the tubes.
 - b. Coils shall have stainless steel casings all around no lighter than 16 gauge and shall have intermediate stainless steel or aluminum stiffeners if over 5'-0" in length. All intermediate and end tube sheets shall be stainless steel. The coil sections shall be supported above the main drain pan with stainless steel channels.
 - c. Tubes shall be 5/8" O.D. shall be spaced approximately 1-1/2" apart and shall have a minimum wall thickness as specified herein. Configured plate fins shall have a minimum thickness of 0.0075".
 - d. Coils shall have copper pipe or cast iron headers as required for working pressure specified and have a valved manual air vent connections except on those return connections where the coil header piping is designed to be self-venting. Coils shall be furnished with a valved manual drain connection located over the unit drain pan at an accessible location. Coil construction shall be:
 - 1) 150 psig working pressure:
 - a) 5/8 x 0.020" minimum wall thickness copper tubes
 - b) Minimum 0.065" wall thickness copper headers
 - c) Copper end caps
 - d) Vent and drain located as required to facilitate service
 - e) Coil tubes extended into header
 - f) Test pressure – 250 psig
 - 2) 300 psig working pressure:
 - a) Heavy duty header construction required
 - b) 5/8 x 0.020" minimum wall thickness copper tubes
 - c) Vent and drain located on face (vent and drain not allowed in end cap)
 - d) 5/8 x 0.049" wall thickness copper adapter tubes between coil tube and header
 - e) Heavy duty end caps
 - f) Type "K" copper headers (.095 wall)
 - g) Test pressure – 350 psig
 - 3) 400 psig working pressure:
 - a) Heavy duty coil construction required
 - b) 5/8 x 0.035" minimum wall thickness copper tubing
 - c) Heavy wall copper headers (0.187 minimum) wall thickness
 - d) Heavy duty end caps
 - e) Vent and drain located on the face (vent and drain not allowed in end cap)
 - f) 5/8 x 0.049" wall thickness copper adapter tubes between coil tube and header
 - g) Test pressure – 450 psig
 - e. Coils shall be tested by air pressure under water at the coil manufacturer's factory. Coils shall be tested at the specified pressure classification herein and as indicated on the riser diagrams, but the test pressure shall in no case be less than 250 psig or more than 500 psig. Submit the factory test log to the Engineer and Owner for record prior to installation of the coil in the air handling unit.
 - f. Chilled water cooling coil shall be not less than six (6) rows deep with not more than 148 fins per foot, but shall be more rows if required to meet or exceed the specified design load for the sensible heat removal requirements as well as the total heat removable. Chilled water cooling coil ratings shall be in accordance with AHRI (Standard 410) certified data except capacity shall meet design capacity without any design tolerance and the temperature variation tested as specified herein-after. Cooling coil capacity shall be in accordance with chilled water flow and temperatures scheduled on the Contract Documents. Water velocity in the tubes shall not exceed five (5) feet per second and the water pressure drop through the coil shall not exceed 25 feet w.g. at design conditions. Water velocity in the tubes shall not be laminar flow at thirty-six (36%) percent of the design water quantity scheduled on the Contract Documents. Coils shall be equipped with bronze spring type turbulators, if required, to meet the specified capacity. Cooling coil face velocities shall be limited to a maximum face velocity of 500 fpm unless otherwise indicated in the schedules on the Contract Documents.
 - g. The cooling coil shall be tested under laboratory conditions at thirty-five (35%) percent, fifty (50%) percent, seventy-five (75%) percent and one hundred (100%) percent load conditions of water flow and air flow, unless previous test data has been submitted and accepted by the Engineer. The test

- shall be run in accordance with AHRI test procedures at the ETL laboratory facilities or approved equal. The test shall be with the design capacities listed in the schedules on the Contract Documents. The test at one hundred (100%) percent capacity shall be with the design air flow and water flow and the total heat transfer and leaving air temperature shall be determined. Tests at other load points shall be at the test CFM and design leaving air temperature and the water quantity required shall be determined. Capacities shall be corrected for altitude effects.
- h. The total variation of the supply air temperature in a plane perpendicular to the air flow direction at the outlet of the discharge plenum shall not exceed 2°F at one hundred (100%) percent design air flow.
 - i. Coil calculations and selection data certified to AHRI Standard 410 shall be submitted with Shop Drawings.
10. An integral casing section for filter media and galvanized or painted frames suitable to accommodate the specified air filters at maximum filter face velocity of 500 fpm shall be furnished by the Division 23 Subcontractor. Filter media for the air handling units shall be as specified in Section 23 40 00 titled "Air Filtering" and as noted in the schedules on the Contract Documents.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All factory-built air handling units shall be installed in accordance with the latest industry standards, per the manufacturer's recommendations and as indicated on the Drawings.
- B. All factory-built air handling units shall be elevated above the floor slabs to allow for proper cooling coil condensate drainage through the traps.
- C. Install each unit on isolation as specified in Section 23 05 48 titled "Vibration Isolation".

3.2 FACTORY TESTING

- A. All factory-built air handling units shall be tested in accordance with the latest applicable industry standards as specified herein and be UL or ETL listed.
- B. The Owner and/or Engineer may observe the air handling units for this Project under manufacture at the factory prior to shipment, if he so desires. The Mechanical Subcontractor shall notify the Owner and Engineer in writing at three (3) weeks prior to the first air handling unit production date.

3.3 FIELD TESTING

- A. Prior to execution of field testing, submit test procedures, recording forms, and test equipment cut sheets to Engineer for review. Refer to Section 23 00 20 titled "Scope of Work" for "Scheduling Procedures".
- B. Refer to Section 23 05 93 for additional testing requirements for factory built air handling units.

END OF SECTION 23 73 23