

Suggested Specifications

Factory-Built Fan Coil Units • Section 15 – – –

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions and the following Specification sections apply to all Work herein:

1. (List related documents here)

1.02 SUMMARY

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

1.03 REFERENCE STANDARDS

A. All factory-built fan coil 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. ASTM Standards C-665 and G-21
3. NFPA 90A, 90B and 255
4. UL 723
5. ARI Standard 410, 440 and 350

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.

1.04 SUBMITTALS AND PROPOSALS

A. The following submittal data shall be furnished according to the General Conditions and Section 15 – – – and shall include, but not be limited to:

1. Vertical Hi-Rise Stack Fan Coil Units* complete with fan and coil selection data, calculations, physical dimensions, horsepower, starting requirements, motor details, etc. Shop Drawings shall indicate specifically that the construction, fabrication, etc., of the units to be furnished complies with these Specifications.
2. Horizontal Ceiling Concealed Fan Coil Units* complete with fan and coil selection data, calculations, physical dimensions, horsepower, starting requirements, motor details, etc. Shop Drawings shall indicate specifically that the construction, fabrication, etc., of the units to be furnished complies with these Specifications.
3. Underfloor Fan Coil Units* complete with fan and coil selection data, calculations, physical dimensions, horsepower, starting requirements, motor details, etc. Shop Drawings shall indicate specifically that the construction, fabrication, etc., of the units to be furnished complies with these Specifications.

B. The factory-built fan coil unit manufacturer shall include a specification Compliance Review report as described in Section 15 – – – with his bid proposal. The Compliance Review will be a paragraph-by-paragraph review of the specifications with the following designations "C", "D", "E" or "N/A" marked in the right hand margin beside each paragraph.

C. All items or equipment listed above with asterisks (*) shall be certified by the manufacturer using Manufacturer Certification "MCA" as set forth in Section 15 – – –. See Section 15 – – – for certification requirements.

1.05 WARRANTY

A. Comply with the requirements of the General Conditions and Section 15 – – –.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. If it complies with these Specifications, factory-built vertical high rise variable speed fan coil units manufactured by one of the following manufacturers will be acceptable:

1. Nailor Industries

B. If it complies with these Specifications, factory-built ceiling concealed variable speed fan coil units manufactured by one of the following manufacturers will be acceptable:

1. Nailor Industries

C. If it complies with these Specifications, factory-built underfloor variable speed fan coil units manufactured by one of the following manufacturers will be acceptable:

1. Nailor Industries

D. If it complies with these Specifications, water coils manufactured by one of the following manufacturers will be acceptable:

1. Great American Coil Co
2. Heatcraft
3. Nailor Industries

E. If it complies with these Specifications, electric heating coils manufactured by one of the following manufacturers will be acceptable:

1. Nailor Industries

2.02 FACTORY-BUILT VERTICAL HIGH RISE VARIABLE VOLUME FAN COIL UNITS

A. Factory-built vertical high rise fan coil units shall be as indicated on the Mechanical and Architectural Drawings and shall meet the capacity and acoustical performance requirements specified and indicated in the schedules on the Contract Documents. All vertical fan coil units shall be tested in accordance with the latest version of ARI Standard 440. All vertical fan coil units shall be UL or ETL listed as a complete factory wired assembly.

B. All unit chassis shall be fabricated of 18 gauge, G-60 galvanized steel panels able to meet 125 hour salt spray test per ASTM B-117. All exterior panels shall be insulated with 1/2" thick, 2lb. per cubic foot Certain Teed ToughGard insulation with a max velocity of 6000 f.p.m. and tested to 9600 f.p.m. Insulation shall conform to UL 181 for erosion and NFPA 90A and NFPA 90B, for fire and smoke, and carry no more than a 25/50 Flame Spread and Smoke Developed Rating, per ASTM E-84 and UL 723. In addition it shall also meet ASTM Standards C-665 and G-21 for biological growth in insulation and has a water repellency rating of ≥ 4 (INDA IST 80.6-92). Fan deck shall be minimum 16 gauge galvanized steel. The fan coil unit cabinets shall be designed to have the gypsum wall board applied directly to the fan coil unit surface and all openings for registers, grilles and openings shall have standard 1/2" drywall flanges. Exposed metal surfaces shall be powder coat painted over electro-galvanized sheet steel. Paint shall be TGIC-Polyester powder with adhesion rating of 5B. Pencil hardness shall be H to 2H and shall have salt-spray resistance per ASTM B-117. No field installed framing around the cabinet openings shall be required. After the completed field installation, only the fan coil unit controls device, supply registers and return air grille and front cover shall be visible. All units that have decorator front panels shall be fabricated of not less than 18 gauge G60 galvanized steel. The front panel shall include a commercial style louver return air grille and be attached with quarter turn quick open fasteners to allow for easy removal and access for service.

C. The welded cooling coil condensate drain pan shall have 1" sides and be fabricated of 20 gauge, 304 stainless steel and internally sloped to drain completely dry upon fan coil unit shutdown. The drain

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pan shall be externally insulated with minimum 1/4" thick elastomer foam fire retardant insulation similar to Armstrong Type AT Armaflex. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of "0, no observed growth" per ASTM G-21. Insulation shall be adhered to the stainless steel drain pan with a full coat of waterproof adhesive. Fan coil units shall have a factory piped and insulated condensate drain and p-traps suitable for field connection to the condensate riser indicated on the Drawings. Drain pan and p-trap shall be removable without disturbing the coil.

D. All coils shall be ARI 410 certified and tagged with an ARI 410 label. All cooling and heating coils shall have the minimum rows required to meet the specified capacity. Coils shall have 1/2" O.D. seamless copper tubes, and collared and corrugated aluminum fins. All tubes shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin. Coil frames shall be constructed of minimum G-90 galvanized steel. All coils shall be pressure tested under water at 1.5 times the working pressure classification indicated in the Contract Documents, but the test pressure in no case shall be less than 300 psig. Heating coils shall be furnished in the reheat position as standard. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Water velocity in the tubes shall not exceed eight (8) feet per second and the coil face velocity shall not exceed 500 fpm. The coils shall be factory piped with Type (K, L, or M) copper pipe with wrought copper fittings and brazed joints. The factory piped assembly shall include: manual air vent, two (2) position quiet actuation electric control valve assemblies as specified, extended handle supply and return ball valves, temperature and pressure test ports in the supply and return lines similar to "Petes Plugs". The ball valve on the balancing return piping shall be equipped with a memory stop and locking feature. Control valves shall be piped normally closed to the coil unless modulating valves are used then the 0-10volt signal will set the valve opening. Maximum entering water temperature on the control valve shall be 200°F, and maximum close-off pressure differential of 25 PSIG. Maximum operating pressure shall be 300 PSIG. Piping packages shall include stainless steel braided hoses to allow for thermal expansion within the unit cabinet. The hose shall be EPDM inner lined and Kevlar reinforced, with solid brass FNPT swivels and/or ball valves. The hoses shall be rated for a minimum 450 PSIG working pressure at 250°F, and carry no more than a 25/50 Flame Spread and Smoke Developed Rating, per ASTM E-84 and UL 723. Piping packages shall be completely factory assembled, including interconnecting pipe, and mounted inside the unit in a serviceable location over the primary drain pan. Refer to Specification Section 15 --- titled, "Pipes, Valves, Fittings and Accessories" for ball valve and pipe fabrication specifications. Refer to Specification Section 15 --- titled "Vibration Isolation".

E. Each unit shall be supplied with Ultraviolet Disinfection for HVAC Mold, Bacteria & Odor Control.

1. Fixturing shall consist of a lamp, lamp clasps, UVC resistant wiring harness, power supply and power supply housing.
2. Each lamp shall contain no more than 5 milligrams of mercury. Lamp output shall be the same as that used in the modeling software. Lamp life shall be 9000 hours with no more than a 20% output loss at the end of the lamps life. Lamps shall be constructed with UVC proof metal bases and shall not produce ozone. When used for surface irradiation, the lamp assembly selected shall be equal to or no less than a minimum of 90% of the surfaces width.
3. Fixtureless lamps are to be installed in sufficient quantity and in such a manner so as to provide an equal distribution of UVC energy. When installed, the UVC energy produced shall be of the lowest possible reflected and shadowed losses. Note: the applied energy and

its distribution shall be verified using third party algorithms and that verification shall be included with the submittal.

4. The minimal UVC energy striking a surface shall be sufficient to continuously destroy a monolayer of mold and bacteria in less than six hours when at 55-135°F. The third party modeling shall include the destruction time for at least four of the most common fan coil surface microbes.
5. Lamp Clasps may be permanently or magnetically affixed to the irradiated cavity. They shall be constructed of high memory, plated steel for maximum holding power and corrosion resistance.
6. Lamp Harness shall be of sufficient length to facilitate lamp connection to remotely located ballast. It shall include a grommet to facilitate safe passage through sheet metal and into the ballast housing. Lamps shall be capable of being mounted anywhere in the system and/or as shown on the plans.
7. Power supplies shall be of the high efficiency electronic type, matched to the lamp and designed to maximize UVC photon production and reliability. They shall be UL Listed and labeled for use in air-streams of 55-135°F. They shall be capable of producing the specified output and organism destruction as listed under Irradiation and Intensity above at no more than 13 Watts of power consumption for each square foot of treated, cross sectional plane.
8. Fixturing shall be electrically terminated to within factory supplied ballast housings to meet NEC and local codes. Lamps shall be mounted to irradiate the intended surface(s) as well as all of the available line of sight airstream by proper placement and incident angle reflection. Proper lamp placement shall be consistent with the third party Irradiation and Intensity calculations provided in the submittal if such placement is absent on the plans.
9. To protect maintenance personnel, all access panels and doors to the UVC assembly and/or within view of the UVC assembly must include mechanical interlock switch(es) to insure that the UVC assembly will be de-energized when any of these accesses are opened.
10. For complete safety, the UVGI equipment shall have been tested, Listed and labeled as an integral part of the fan coil unit by the fan coil manufacturer, no exceptions.

F. Vertical Fan Coil Unit Electric Heating Coils:

1. Furnish an electric resistance heating assembly as an integral part of the fan coil unit, with the heating capacity, voltage, and kilowatts scheduled. Electric heating coils shall consist of open coils of highest grade 80% nickel and 20% chromium resistance wire or nichrome elements and insulated with ceramic, phenolic or lava insulators in aluminized steel, galvanized steel or stainless steel brackets, supported in heavy gauge aluminized or galvanized steel frames. Each unit employing an electric heating coil shall be constructed and installed in accordance with the requirements of the local authorities and shall be UL or ETL listed specifically with the heater as a component of the fan coil unit device.
2. All heating elements shall be open coil type Ni-Chrome wire mounted in ceramic insulators and located in an insulated heavy gauge galvanized steel housing. All elements shall terminate in a machine staked terminal secured with corrosion resistant hardware. The element support brackets shall be spaced no greater than 3-1/2" on center.
3. Coils shall have the capacities indicated in Contract Documents. Coils shall be single or three phase, 60 hertz with voltage requirements as indicated in the Contract Documents Electric heating coils up to and including 3kW shall be single stage. Electric coils above 3kW shall be two (2) stages.
4. Terminal bolts, nuts and washers shall be of corrosion resistant materials. Coils shall be constructed so the installation may be

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accomplished in accordance with the provisions of the National Electrical Code, for zero (0) clearance. Coils shall be given a 2000 Volt dielectric test at the factory.

5. Automatic reset thermal cut-outs and an airflow switch or CT relay shall be furnished for heater protection. The airflow switch or relay shall prove adequate fan airflow before the electric heater can be energized. Both devices shall be serviceable through fan coil unit without removing heating element from the unit.

6. Heating coils shall have a terminal box and cover, with either SCR controls or quiet type built-in mercury step controlled contactors for each circuit, branch circuit fusing for each circuit in excess of 48 amps per the NEC and a static pressure or air flow safety interlock switch for installation in the heater control enclosure. Provide a separate control power transformer in accordance with NEC requirements and the local authorities having jurisdiction.

7. All wiring of built-in devices shall be brought to clearly marked terminal strips. A complete wiring diagram shall be permanently attached to the heating coil panel cover.

8. Shop Drawings shall be submitted for review as specified in Section 15 ---. These Shop Drawings shall indicate specifically the exact construction, materials, internal wiring, NEC working clearances, etc., of the fan coil units and electric heating coils to be furnished under these Specifications.

G. Centrifugal fan blower wheels shall be forward curved type, double width, double inlet direct drive type selected for maximum efficiency and an acoustical performance in accordance with the Project acoustical criteria specified in the Contract Documents. Unit fan shall be constructed of zinc coated galvanized steel for corrosion resistance. The fan assembly shall be removed and serviced through the front of the unit. The entire assembly shall be able to come out of the unit easily by removing four lock nuts and unplugging the motor.

H. Fan motors shall be ECM or Nailor EPIC variable speed DC brushless motors specifically designed for use with a single phase, (120, 208, 240, 277) Volt, 60 hertz electrical input. Motor shall be complete with and operated by a single phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero (0) rotor losses. Motor shall have built-in soft start and slowed speed change ramps. Motor shall be permanently lubricated with ball bearings. Motor shall be direct coupled to the blower. Motor shall maintain a minimum of sixty-five (65%) percent efficiency over its entire operating range. Provide isolation between fan motor assembly and unit casing in at least four (4) locations to eliminate any vibration from the fan to the terminal unit casing. Provide isolation between the motor and blower as well as between the blower and casing.

I. If factory furnished piping risers are indicated on the Contract Documents, they shall be in Type "(K, L, M)" seamless copper and include a 3" long up-sized or swaged section at the top to accept the riser from above without requiring a coupling. This swaged section is designed for a 2" insertion length to assure field joint integrity. Risers shall be integral to the unit. Slip couplings may be used on pipe that cannot be swaged. All risers, including the drain, shall be insulated with (1/2, 3/4, 1)" closed cell foam insulation covering the entire riser. Insulation shall conform to NFPA 90A and carry no more than a 25/50 Flame Spread and Smoke Developed Rating, per ASTM E-84 and UL 723. This insulation covers the full riser length and does not require field furnished insulation at the field joints.

J. One (1) piece risers are available in lengths up to 115" in 1" increments. The fan coil unit installing contractor shall provide integral expansion compensators in the riser piping at least every five (5) floors. The fan coil unit manufacturer shall perform a piping stress riser

and expansion/contraction analysis. The stress analysis shall be provided to the Engineer for review. Floor-to-floor lengths over 113" will normally have 104" unit risers and separate between-the-floor riser extensions. Standard unit construction will accommodate a maximum of a 3-1/8" diameter chilled water supply and return, 3-1/8" diameter hot water supply and return and 1-1/4" diameter condensate

K. The vertical fan coil unit manufacturer shall furnish a wall mounted control package shipped loose for field installation. The wall mounted sensor controller shall be provided with quick connect plugs. The control package shall provide automatic changeover from heating to cooling. The fan coil unit manufacturer shall furnish and install a dynamic fan volume control system to automatically vary the fan airflow in response to heating and cooling load. The wall mounted control device in the room shall allow automatic fan modulation based on room load demand. The fan speed shall change slowly. No manual speed selection will be required at the wall mounted control device. Provide an add alternate (M _____) to provide the DDC sensor/controller with the capability to be incorporated into the Division 17 Building Management and Control System or "Smart Room" technology to start and stop the unit, remotely reset the space temperature and control the outside air (on-off) to the room. The fan coil unit manufacturer shall demonstrate the performance of the vertical fan coil unit dynamic volume control sequence, the associated two (2) position heating control valve and the modulating cooling control valve with the DDC controller in an independent testing laboratory. The acceptability of the independent testing laboratory is subject to review by the Owner and Engineer. The vertical fan coil unit manufacturer shall submit complete test details, brochures, instrumentation, etc., for review. If the vertical fan coil unit manufacturer has conducted the herein specified dynamic volume control performance tests and has demonstrated to the Engineer and Owner compliance with the specified criteria, the previous testing will be accepted and will not need to be repeated. See Section 15 --- titled "Design Conditions". The fan coil unit shall be capable of operation as described herein with discharge static pressure of 0 to 0.5" w.g. (120 Pa) at full airflow. (See SEQUENCE OF OPERATION for further information.)

L. The entire vertical fan coil unit assembly shall be factory wired to a single point connection. All power and control wiring shall conform to National Electric Code Standards and local requirements of the authorities having jurisdiction. The fan coil unit assembly shall include all required devices, including but not limited to, service switch, relay, control power transformers and control packages, low voltage remote shutdown relays, etc.

M. The vertical fan coil unit manufacturer shall furnish a steel double deflection supply diffuser with 3/4" bar spacing similar to Nailor Model 61DV-O and a steel return air grille similar to Nailor Model 5145H-OA. Opposed blade volume dampers are not required. The fan coil unit shall be equipped with a return air access panel with frame, which incorporates the steel return air grille, as required for complete access to the fan, blower, coil and piping assembly. The access panel shall be fastened with quarter-turn type fasteners. If required, the fan coil shall be equipped with an outside air damper integral to the unit. The damper shall be capable of pressure independent operation with DDC controller or pressure dependent operation with manual quadrant. If the damper is controlled by DDC controls, see controls specification for controls requirements.

N. The fan coil unit manufacturer shall furnish the unit with 1" thick pleated MERV 7 throw-away type media air filters. Refer to Specification Section 15 --- titled "Air Filtering" for requirements.

O. The vertical fan coil unit and acoustical treatment shall limit the noise in the room 3' away from any discharge and return air opening to an amount that will not produce more than the NC sound curve specified in Section 15 --- titled "Design Conditions".

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P. Each size of the vertical fan coil unit installed on this Project shall be completely acoustically tested in the Owner's room mock-up or an independent laboratory for air performance and acoustics. The acceptability of the independent testing laboratory is subject to review by the Owner, Project Acoustical Consultant, and the Engineer. The fan coil unit manufacturer shall submit complete test details, brochures, instrumentation information, etc., for review. The air volume listed on the Drawings or in the schedules for the fan coil units shall be tested. If the fan coil unit manufacturer has conducted the hereinbefore specified air performance and acoustical tests and has demonstrated to the Engineer and Owner compliance with the specified Project criteria, the previous testing will be accepted and will not need to be repeated. See Section 15 – – – titled "Design Conditions". Base sound power data shall be provided as tested according to the latest version of ARI Standard 350. This data is for guideline purposes only, the mock up described above is the qualifying test.

Q. The vertical fan coil unit manufacturer shall submit six (6) certified copies of the field performance and acoustical performance test results to the Engineer and the Project Acoustical Consultant. See Section 15 – – – titled "General Requirements" for additional submittal and certification requirements.

R. The vertical fan coil manufacturer shall verify at the manufacturer's factory the operation of each fan coil before shipment. Testing shall include at least the following:

1. Apply electric power to the unit.
2. Start the fan and verify fan rotates properly.
3. Energize the electric two (2) position and modulating control valves and verify satisfactory performance.
4. Provide a written inspection report for each unit signed and dated by the factory test technician verifying all fan coil unit wiring and testing has been performed per the manufacturer's testing and quality assurance requirements.

5. The vertical fan coil unit manufacturer shall factory set the brushless "ECM" motor and associated controller/inverter to the maximum discharge airflow for heating and cooling and minimum deadband airflow specified and indicated in the Contract Documents.

2.03 FACTORY-BUILT CEILING CONCEALED HORIZONTAL VARIABLE VOLUME FAN COIL UNITS

A. Factory-built concealed horizontal fan coil units shall be as indicated on the Mechanical and Architectural Drawings and shall meet the capacity and acoustical performance requirements specified and indicated in the schedules on the Contract Documents. All horizontal fan coil units shall be tested in accordance with the latest version of ARI Standard 440. All horizontal fan coil units shall be UL or ETL listed as a complete factory wired assembly.

B. All unit chassis shall be fabricated of 20 gauge, G-60 galvanized steel panels able to meet 125 hour salt spray test per ASTM B-117. All exterior panels shall be insulated with 1/2" thick, 2lb. per cubic foot Certain Teed ToughGard insulation with a max velocity of 6000 f.p.m. and tested to 9600 f.p.m. Insulation shall conform to UL 181 for erosion and NFPA 90A and NFPA 90B, for fire and smoke, and carry no more than a 25/50 Flame Spread and Smoke Developed Rating, per ASTM E-84 and UL 723. In addition it shall also meet ASTM Standards C-665 and G-21 for biological growth in insulation and has a water repellency rating of ≥ 4 (INDA IST 80.6-92). Fan deck shall be minimum 20 gauge galvanized steel. The fan coil unit shall have a flat discharge panel to facilitate a flanged duct connection being screwed directly to the unit. The unit face shall be free and clear of obstructions for the sheet metal screw penetrations. Units that are designed for exposed mounting shall have smooth discharge openings for mounting grilles directly to the unit face.

C. The welded cooling coil condensate drain pan shall have 1" sides

and be fabricated of 20 gauge, 304 stainless steel. The unit shall be designed to be installed sloped to drain completely dry upon fan coil unit shutdown. The drain pan shall be externally insulated with minimum 1/4" thick elastomer foam fire retardant insulation similar to Armstrong Type AT Armaflex. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of "0, no observed growth" per ASTM G-21. Insulation shall be adhered to the stainless steel drain pan with a full coat of waterproof adhesive.

D. All coils shall be ARI 410 certified and tagged with an ARI 410 label. All cooling and heating coils shall have the minimum rows required to meet the specified capacity. Coils shall have 1/2" O.D. seamless copper tubes, and collared and corrugated aluminum fins. All tubes shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin. Coil frames shall be constructed of minimum G-90 galvanized steel. All coils shall be pressure tested under water at 1.5 times the working pressure classification indicated in the Contract Documents, but the test pressure in no case shall be less than 300 psig. Heating coils shall be furnished in the reheat position as standard. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Water velocity in the tubes shall not exceed eight (8) feet per second and the coil face velocity shall not exceed 500 fpm. The coils shall be factory piped with Type (K, L, or M) copper pipe with wrought copper fittings and brazed joints. The factory piped assembly shall include: manual air vent, two (2) position quiet actuation electric control valve assemblies as specified, extended handle supply and return ball valves, temperature and pressure test ports in the supply and return lines similar to "Petes Plugs". The ball valve on the balancing return piping shall be equipped with a memory stop and locking feature. Control valves shall be piped normally closed to the coil unless modulating valves are used then the 0-10volt signal will set the valve opening. Maximum entering water temperature on the control valve shall be 200°F, and maximum close-off pressure differential of 25 PSIG. Maximum operating pressure shall be 300 PSIG. Piping packages shall be completely factory assembled, including interconnecting pipe, and mounted inside the unit in a serviceable location over the primary or secondary drain pan. Refer to Specification Section 15 – – – titled, "Pipes, Valves, Fittings and Accessories" for ball valve and pipe fabrication specifications. Refer to Specification Section 15 – – – titled "Vibration Isolation".

E. Each unit shall be supplied with Ultraviolet Disinfection for HVAC Mold, Bacteria & Odor Control.

1. Fixturing shall consist of a lamp, lamp clasps, UVC resistant wiring harness, power supply and power supply housing.
2. Each lamp shall contain no more than 5 milligrams of mercury. Lamp output shall be the same as that used in the modeling software. Lamp life shall be 9000 hours with no more than a 20% output loss at the end of the lamps life. Lamps shall be constructed with UVC proof metal bases and shall not produce ozone. When used for surface irradiation, the lamp assembly selected shall be equal to or no less than a minimum of 90% of the surfaces width.
3. Fixtureless lamps are to be installed in sufficient quantity and in such a manner so as to provide an equal distribution of UVC energy. When installed, the UVC energy produced shall be of the lowest possible reflected and shadowed losses. Note: the applied energy and its distribution shall be verified using third party algorithms and that verification shall be included with the submittal.
4. The minimal UVC energy striking a surface shall be sufficient to continuously destroy a monolayer of mold and bacteria in less than six hours when at 55-135°F. The third party modeling shall include the destruction time for at least four of the most common fan coil surface microbes.

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5. Lamp Clasps may be permanently or magnetically affixed to the irradiated cavity. They shall be constructed of high memory, plated steel for maximum holding power and corrosion resistance.
6. Lamp Harness shall be of sufficient length to facilitate lamp connection to remotely located ballast. It shall include a grommet to facilitate safe passage through sheet metal and into the ballast housing. Lamps shall be capable of being mounted anywhere in the system and/or as shown on the plans.
7. Power supplies shall be of the high efficiency electronic type, matched to the lamp and designed to maximize UVC photon production and reliability. They shall be UL Listed and labeled for use in air-streams of 55-135°F. They shall be capable of producing the specified output and organism destruction as listed under Irradiation and Intensity above at no more than 13 Watts of power consumption for each square foot of treated, cross sectional plane.
8. Fixturing shall be electrically terminated to within factory supplied ballast housings to meet NEC and local codes. Lamps shall be mounted to irradiate the intended surface(s) as well as all of the available line of sight airstream by proper placement and incident angle reflection. Proper lamp placement shall be consistent with the third party Irradiation and Intensity calculations provided in the submittal if such placement is absent on the plans.
9. To protect maintenance personnel, all access panels and doors to the UVC assembly and/or within view of the UVC assembly must include mechanical interlock switch(es) to insure that the UVC assembly will be de-energized when any of these accesses are opened.
10. For complete safety, the UVGI equipment shall have been tested, Listed and labeled as an integral part of the fan coil unit by the fan coil manufacturer, no exceptions.

F. Electric Heating Coils:

Furnish an electric resistance heating assembly as an integral part of the fan coil unit, with the heating capacity, voltage, and kilowatts scheduled. Each unit employing an electric heating coil shall be constructed and installed in accordance with the requirements of the local authorities and shall be UL or ETL listed specifically with the heater as a component of the fan coil unit device.

1. All heating elements shall be open coil type Ni-Chrome wire mounted in ceramic insulators and located in an insulated heavy gauge galvanized steel housing. All elements shall terminate in a machine staked terminal secured with corrosion resistant hardware. The element support brackets shall be spaced no greater than 3-1/2" on center.
2. Coils shall have the capacities indicated in Contract Documents. Coils shall be single or three phase, 60 hertz with voltage requirements as indicated in the Contract Documents. Electric heating coils up to and including 3kW shall be single stage. Electric coils above 3kW shall be two (2) stages.
3. Terminal bolts, nuts and washers shall be of corrosion resistant materials. Coils shall be constructed so the installation may be accomplished in accordance with the provisions of the National Electrical Code, for zero (0) clearance. Coils shall be given a 2000 Volt dielectric test at the factory.
4. Automatic reset thermal cut-outs and an airflow switch shall be furnished for heater protection. The airflow switch shall prove adequate fan airflow before the electric heater can be energized. Both devices shall be serviceable through fan coil unit without removing heating element from the unit.
5. Heating coils shall have a terminal box and cover, with either SCR controls or quiet type built-in mercury step controlled contactors for each circuit, branch circuit fusing for each circuit in excess of 48 amps

per the NEC and a static pressure or air flow safety interlock switch for installation in the heater control enclosure. Provide a separate control power transformer in accordance with NEC requirements and the local authorities having jurisdiction.

6. All wiring of built-in devices shall be brought to clearly marked terminal strips. A complete wiring diagram shall be permanently attached to the heating coil panel cover.

7. Shop Drawings shall be submitted for review as specified in Section 15----. These Shop Drawings shall indicate specifically the exact construction, materials, internal wiring, NEC working clearances, etc., of the fan coil units and electric heating coils to be furnished under these Specifications.

G. Centrifugal fan blower wheels shall be forward curved type, double width, double inlet direct drive type selected for maximum efficiency and an acoustical performance in accordance with the Project acoustical criteria specified in the Contract Documents. Unit fan shall be constructed of zinc coated galvanized steel for corrosion resistance. The fan assembly shall be easily removable for service.

H. Fan motors shall be ECM or Nailor EPIC variable speed DC brushless motors specifically designed for use with a single phase, (120, 208, 240, 277) Volt, 60 hertz electrical input. Motor shall be complete with and operated by a single phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero (0) rotor losses. Motor shall have built-in soft start and slowed speed change ramps. Motor shall be permanently lubricated with ball bearings. Motor shall be direct coupled to the blower. Motor shall maintain a minimum of sixty-five (65%) percent efficiency over its entire operating range. Provide isolation between fan motor assembly and unit casing in at least four (4) locations to eliminate any vibration from the fan to the terminal unit casing. Provide isolation between the motor and blower as well as between the blower and casing.

K. The fan coil unit manufacturer shall furnish a wall mounted control package shipped loose for field installation. The wall mounted sensor controller shall be provided with quick connect plugs. The control package shall provide automatic changeover from heating to cooling. The fan coil unit manufacturer shall furnish and install a dynamic fan volume control system to automatically vary the fan airflow in response to heating and cooling load. The wall mounted control device in the room shall allow automatic fan modulation based on room load demand. The fan speed shall change slowly. No manual speed selection will be required at the wall mounted control device. Provide an add alternate (M_____) to provide the DDC sensor/controller with the capability to be incorporated into the Division 17 Building Management and Control System or "Smart Room" technology to start and stop the unit, remotely reset the space temperature and control the outside air (on-off) to the room. The fan coil unit manufacturer shall demonstrate the performance of the fan coil unit dynamic volume control sequence, the associated two (2) position heating control valve and the modulating cooling control valve with the DDC controller in an independent testing laboratory. The acceptability of the independent testing laboratory is subject to review by the Owner and Engineer. The fan coil unit manufacturer shall submit complete test details, brochures, instrumentation, etc., for review. If the fan coil unit manufacturer has conducted the herein specified dynamic volume control performance tests and has demonstrated to the Engineer and Owner compliance with the specified criteria, the previous testing will be accepted and will not need to be repeated. See Section 15---- titled "Design Conditions". The fan coil unit shall be capable of operation as described herein with discharge static pressure of 0 to 0.5" w.g. (120 Pa) at full airflow. (See SEQUENCE OF OPERATION for further information.)

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L. The entire fan coil unit assembly shall be factory wired to a single point connection. All power and control wiring shall conform to National Electric Code Standards and local requirements of the authorities having jurisdiction. The fan coil unit assembly shall include all required devices, including but not limited to, service switch, relay, control power transformers and control packages, low voltage remote shutdown relays, etc.

M. If required, the fan coil shall be equipped with an outside air damper integral to the unit. The damper shall be capable of pressure independent operation with DDC controller or pressure dependent operation with manual quadrant. If the damper is controlled by DDC controls, see controls specification for controls requirements.

N. The fan coil unit manufacturer shall furnish the unit with 1" thick pleated MERV 7 throw-away type media air filters. Refer to Specification Section 15 --- titled "Air Filtering" for requirements.

O. The fan coil unit and acoustical treatment shall limit the noise in the room 3' away from any discharge and return air opening to an amount that will not produce more than the NC sound curve specified in Section 15 --- titled "Design Conditions".

P. Each size of fan coil unit installed on this Project shall be completely acoustically tested in the Owner's room mock-up or an independent laboratory for air performance and acoustics. The acceptability of the independent testing laboratory is subject to review by the Owner, Project Acoustical Consultant, and the Engineer. The fan coil unit manufacturer shall submit complete test details, brochures, instrumentation information, etc., for review. The air volume listed on the Drawings or in the schedules for the fan coil units shall be tested. If the fan coil unit manufacturer has conducted the hereinbefore specified air performance and acoustical tests and has demonstrated to the Engineer and Owner compliance with the specified Project criteria, the previous testing will be accepted and will not need to be repeated. See Section 15 --- titled "Design Conditions". Base sound power data shall be provided as tested according to the latest version of ARI Standard 350. This data is for guideline purposes only, the mock up described above is the qualifying test.

Q. The fan coil unit manufacturer shall submit six (6) certified copies of the field performance and acoustical performance test results to the Engineer and the Project Acoustical Consultant. See Section 15 --- titled "General Requirements" for additional submittal and certification requirements.

R. The fan coil manufacturer shall verify at the manufacturer's factory the operation of each fan coil before shipment. Testing shall include at least the following:

1. Apply electric power to the unit.
2. Start the fan and verify fan rotates properly.
3. Energize the electric two (2) position and modulating control valves and verify satisfactory performance.
4. Provide a written inspection report for each unit signed and dated by the factory test technician verifying all fan coil unit wiring and testing has been performed per the manufacturer's testing and quality assurance requirements.

S. The fan coil unit manufacturer shall factory set the brushless "ECM" motor and associated controller/inverter to the maximum discharge airflow for heating and cooling and minimum deadband airflow specified and indicated in the Contract Documents.

2.04 FACTORY-BUILT UNDERFLOOR HORIZONTAL VARIABLE VOLUME FAN COIL UNITS

A. Factory-built underfloor fan coil units shall be as indicated on the Mechanical and Architectural Drawings and shall meet the capacity and acoustical performance requirements specified and indicated in the schedules on the Contract Documents. All underfloor fan coil units shall be tested in accordance with the latest version of ARI Standard

440. All underfloor fan coil units shall be UL or ETL listed as a complete factory wired assembly.

B. Unit chassis shall be fabricated of 20 gauge, G-60 galvanized steel panels able to meet 125 hour salt spray test per ASTM B-117. Exterior panels, which are scheduled to be insulated, shall be insulated with 1/2" thick, 2lb. per cubic foot Certain Teed ToughGard insulation with a max velocity of 6000 f.p.m. and tested to 9600 f.p.m. Insulation shall conform to UL 181 for erosion and NFPA 90A and NFPA 90B, for fire and smoke, and carry no more than a 25/50 Flame Spread and Smoke Developed Rating, per ASTM E-84 and UL 723. In addition it shall also meet ASTM Standards C-665 and G-21 for biological growth in insulation and has a water repellency rating of ≥ 4 (INDA IST 80.6-92). Fan deck shall be minimum 20 gauge galvanized steel. The fan coil unit shall have a flat discharge panel to facilitate a flanged duct connection being screwed directly to the unit. The unit face shall be free and clear of obstructions for the sheet metal screw penetrations.

C. The welded cooling coil condensate drain pan shall have 1" sides and be fabricated of 20 gauge, 304 stainless steel. The drain pan shall be externally insulated with minimum 1/4" thick elastomer foam fire retardant insulation similar to Armstrong Type AT Armaflex. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of "0, no observed growth" per ASTM G-21. Insulation shall be adhered to the stainless steel drain pan with a full coat of waterproof adhesive.

D. All coils shall be ARI 410 certified and tagged with an ARI 410 label. All cooling and heating coils shall have the minimum rows required to meet the specified capacity. Coils shall have 1/2" O.D. seamless copper tubes, and collared and corrugated aluminum fins. All tubes shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin. Coil frames shall be constructed of minimum G-90 galvanized steel. All coils shall be pressure tested under water at 1.5 times the working pressure classification indicated in the Contract Documents, but the test pressure in no case shall be less than 300 psig. Heating coils shall be furnished in the reheat position as standard. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Water velocity in the tubes shall not exceed eight (8) feet per second and the cooling coil face velocity shall not exceed 500 fpm. The coils shall be factory piped with Type (K, L, or M) copper pipe with wrought copper fittings and brazed joints. The factory piped assembly shall include: manual air vent, two (2) position quiet actuation electric control valve assemblies as specified, extended handle supply and return ball valves, temperature and pressure test ports in the supply and return lines similar to "Petes Plugs". The ball valve on the balancing return piping shall be equipped with a memory stop and locking feature. Control valves shall be piped normally closed to the coil unless modulating valves are used then the 0-10volt signal will set the valve opening. Maximum entering water temperature on the control valve shall be 200°F, and maximum close-off pressure differential of 25 PSIG. Maximum operating pressure shall be 300 PSIG. Piping packages shall be completely factory assembled, including interconnecting pipe, and mounted inside the unit in a serviceable location over the primary or secondary drain pan. Refer to Specification Section 15 --- titled, "Pipes, Valves, Fittings and Accessories" for ball valve and pipe fabrication specifications. Refer to Specification Section 15 --- titled "Vibration Isolation".

E. Each unit shall be supplied with Ultraviolet Disinfection for HVAC Mold, Bacteria & Odor Control.

1. Fixturing shall consist of a lamp, lamp clasps, UVC resistant wiring harness, power supply and power supply housing.

9. Each lamp shall contain no more than 5 milligrams of mercury. Lamp output shall be the same as that used in the modeling software.

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Lamp life shall be 9000 hours with no more than a 20% output loss at the end of the lamps life. Lamps shall be constructed with UVC proof metal bases and shall not produce ozone. When used for surface irradiation, the lamp assembly selected shall be equal to or no less than a minimum of 90% of the surfaces width.

10. Fixtureless lamps are to be installed in sufficient quantity and in such a manner so as to provide an equal distribution of UVC energy. When installed, the UVC energy produced shall be of the lowest possible reflected and shadowed losses. Note: the applied energy and its distribution shall be verified using third party algorithms and that verification shall be included with the submittal.

11. The minimal UVC energy striking a surface shall be sufficient to continuously destroy a monolayer of mold and bacteria in less than six hours when at 55-135°F. The third party modeling shall include the destruction time for at least four of the most common fan coil surface microbes.

12. Lamp Clasps may be permanently or magnetically affixed to the irradiated cavity. They shall be constructed of high memory, plated steel for maximum holding power and corrosion resistance.

13. Lamp Harness shall be of sufficient length to facilitate lamp connection to remotely located ballast. It shall include a grommet to facilitate safe passage through sheet metal and into the ballast housing. Lamps shall be capable of being mounted anywhere in the system and/or as shown on the plans.

14. Power supplies shall be of the high efficiency electronic type, matched to the lamp and designed to maximize UVC photon production and reliability. They shall be UL Listed and labeled for use in air-streams of 55-135°F. They shall be capable of producing the specified output and organism destruction as listed under Irradiation and Intensity above at no more than 13 Watts of power consumption for each square foot of treated, cross sectional plane.

15. Fixturing shall be electrically terminated to within factory supplied ballast housings to meet NEC and local codes. Lamps shall be mounted to irradiate the intended surface(s) as well as all of the available line of sight airstream by proper placement and incident angle reflection. Proper lamp placement shall be consistent with the third party Irradiation and Intensity calculations provided in the submittal if such placement is absent on the plans.

16. To protect maintenance personnel, all access panels and doors to the UVC assembly and/or within view of the UVC assembly must include mechanical interlock switch(es) to insure that the UVC assembly will be de-energized when any of these accesses are opened.

17. For complete safety, the UVGI equipment shall have been tested, Listed and labeled as an integral part of the fan coil unit by the fan coil manufacturer, no exceptions.

F. Electric Heating Coils:

Furnish an electric resistance heating assembly as an integral part of the fan coil unit, with the heating capacity, voltage, and kilowatts scheduled. Each unit employing an electric heating coil shall be constructed and installed in accordance with the requirements of the local authorities and shall be UL or ETL listed specifically with the heater as a component of the fan coil unit device.

1. All heating elements shall be open coil type Ni-Chrome wire mounted in ceramic insulators and located in an insulated heavy gauge galvanized steel housing. All elements shall terminate in a machine staked terminal secured with corrosion resistant hardware. The element support brackets shall be spaced no greater than 3-1/2" on center.

2. Coils shall have the capacities indicated in Contract Documents. Coils shall be single or three phase, 60 hertz with voltage requirements

as indicated in the Contract Documents. Electric heating coils up to and including 3kW shall be single stage. Electric coils above 3kW shall be two (2) stages.

3. Terminal bolts, nuts and washers shall be of corrosion resistant materials. Coils shall be constructed so the installation may be accomplished in accordance with the provisions of the National Electrical Code, for zero (0) clearance. Coils shall be given a 2000 Volt dielectric test at the factory.

4. Automatic reset thermal cut-outs and an airflow switch shall be furnished for heater protection. The airflow switch shall prove adequate fan airflow before the electric heater can be energized. Both devices shall be serviceable through fan coil unit without removing heating element from the unit.

5. Heating coils shall have a terminal box and cover, with either SCR controls or quiet type built-in mercury step controlled contactors for each circuit, branch circuit fusing for each circuit in excess of 48 amps per the NEC and a static pressure or air flow safety interlock switch for installation in the heater control enclosure. Provide a separate control power transformer in accordance with NEC requirements and the local authorities having jurisdiction.

6. All wiring of built-in devices shall be brought to clearly marked terminal strips. A complete wiring diagram shall be permanently attached to the heating coil panel cover.

7. Shop Drawings shall be submitted for review as specified in Section 15---. These Shop Drawings shall indicate specifically the exact construction, materials, internal wiring, NEC working clearances, etc., of the fan coil units and electric heating coils to be furnished under these Specifications.

G. Centrifugal fan blower wheels shall be forward curved type, double width, double inlet direct drive type selected for maximum efficiency and an acoustical performance in accordance with the Project acoustical criteria specified in the Contract Documents. Unit fan shall be constructed of zinc coated galvanized steel for corrosion resistance. The fan assembly shall be easily removable for service.

H. Fan motors shall be ECM or Nailor EPIC variable speed DC brushless motors specifically designed for use with a single phase, (120, 208, 240, 277) Volt, 60 hertz electrical input. Motor shall be complete with and operated by a single phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero (0) rotor losses. Motor shall have built-in soft start and slowed speed change ramps. Motor shall be permanently lubricated with ball bearings. Motor shall be direct coupled to the blower. Motor shall maintain a minimum of sixty-five (65%) percent efficiency over its entire operating range. Provide isolation between fan motor assembly and unit casing in at least four (4) locations to eliminate any vibration from the fan to the terminal unit casing. Provide isolation between the motor and blower as well as between the blower and casing.

K. The fan coil unit manufacturer shall furnish a wall mounted control package shipped loose for field installation. The wall mounted sensor controller shall be provided with quick connect plugs. The control package shall provide automatic changeover from heating to cooling. The fan coil unit manufacturer shall furnish and install a dynamic fan volume control system to automatically vary the fan airflow in response to heating and cooling load. The wall mounted control device in the room shall allow automatic fan modulation based on room load demand. The fan speed shall change slowly. No manual speed selection will be required at the wall mounted control device. Provide an add alternate (M _____) to provide the DDC sensor/controller with the capability to be incorporated into the Division 17 Building Management and Control System or "Smart Room" technology to start

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and stop the unit, remotely reset the space temperature and control the outside air (on-off) to the room. The fan coil unit manufacturer shall demonstrate the performance of the fan coil unit dynamic volume control sequence, the associated two (2) position heating control valve and the modulating cooling control valve with the DDC controller in an independent testing laboratory. The acceptability of the independent testing laboratory is subject to review by the Owner and Engineer. The fan coil unit manufacturer shall submit complete test details, brochures, instrumentation, etc., for review. If the fan coil unit manufacturer has conducted the herein specified dynamic volume control performance tests and has demonstrated to the Engineer and Owner compliance with the specified criteria, the previous testing will be accepted and will not need to be repeated. See Section 15--- titled "Design Conditions". The fan coil unit shall be capable of operation as described herein with discharge static pressure of 0 to 0.5" w.g. (120 Pa) at full airflow. (See SEQUENCE OF OPERATION for further information.)

L. The entire fan coil unit assembly shall be factory wired to a single point connection. All power and control wiring shall conform to National Electric Code Standards and local requirements of the authorities having jurisdiction. The fan coil unit assembly shall include all required devices, including but not limited to, service switch, relay, control power transformers and control packages, low voltage remote shutdown relays, etc.

M. If required, the fan coil shall be equipped with an outside air damper integral to the unit. The damper shall be capable of pressure independent operation with DDC controller or pressure dependent operation with manual quadrant. If the damper is controlled by DDC controls, see controls specification for controls requirements.

N. The fan coil unit and acoustical treatment shall limit the noise in the room 5' away from any discharge and return air opening to an amount that will not produce more than the NC sound curve specified in Section 15---- titled "Design Conditions".

O. Each size of fan coil unit installed on this Project shall be completely acoustically tested in the Owner's room mock-up or an independent laboratory for air performance and acoustics. The acceptability of the independent testing laboratory is subject to review by the Owner, Project Acoustical Consultant, and the Engineer. The fan coil unit manufacturer shall submit complete test details, brochures, instrumentation information, etc., for review. The air volume listed on the Drawings or in the schedules for the fan coil units shall be tested. If the fan coil unit manufacturer has conducted the hereinbefore specified air performance and acoustical tests and has demonstrated to the Engineer and Owner compliance with the specified Project criteria, the previous testing will be accepted and will not need to be repeated. See Section 15---- titled "Design Conditions". Base sound power data shall be provided as tested according to the latest version of ARI Standard 350. This data is for guideline purposes only, the mock up described above is the qualifying test.

P. The fan coil unit manufacturer shall submit six (6) certified copies of the field performance and acoustical performance test results to the Engineer and the Project Acoustical Consultant. See Section 15---- titled "General Requirements" for additional submittal and certification requirements.

Q. The fan coil manufacturer shall verify at the manufacturer's factory the operation of each fan coil before shipment. Testing shall include at least the following:

1. Apply electric power to the unit.
2. Start the fan and verify fan rotates properly.

3. Energize the electric two (2) position and modulating control valves and verify satisfactory performance.

4. Provide a written inspection report for each unit signed and dated by the factory test technician verifying all fan coil unit wiring and testing has been performed per the manufacturer's testing and quality assurance requirements.

R. The fan coil unit manufacturer shall factory set the brushless "ECM" motor and associated controller/inverter to the maximum discharge airflow for heating and cooling and minimum deadband airflow specified and indicated in the contract document.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All factory-built fan coil 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 fan coil units shall be installed to allow for proper cooling coil condensate drainage through the traps.

C. Prior to the installation of multiple fan coil units, the Contractor shall install one of each size of the fan coil units as mock-up conditions generally representative of the typical ceiling plenum installation. The mock-up condition shall be complete with piping, condensate piping ductwork, fan coil unit hangers, control, electrical connections and code clearances. The mock-up installations shall be located within one of the typical areas of the project. The Contractor shall advise the appropriate Local Code Field Inspector, Engineer, and Owner's representative after the mock-up is complete and ready for review and inspection. The Contractor shall arrange a time mutually agreeable to these parties so they can meet at the project site, review the mock-up installation, and determine any changes that need to be made for the installation to be acceptable to the Local Code Field Inspector. Issues regarding access and code NEC clearances plus obstructions and conflicts with other trades within the ceiling plenum will be discussed and mutually agreed upon. The mock-up condition, review of the mock-up condition by the appropriate parties, and the necessary modifications for the mock-up to become code compliant in the opinion of the Local Field Code Authority shall be completed prior to the installation of additional fan coil units. The Contractor shall account for this requirement in the schedule of construction so this procedure does not delay the construction progress. If multiple fan coil units are installed prior to the mock-up approval, the Contractor shall be responsible for the remedial work required to comply with the approved mock-up condition at no additional cost to the Owner. The Contractor shall provide advance notice to the appropriate parties of the fan coil unit's mock-up inspection a minimum of seven working days prior to the meeting. If additional or follow-up field inspections of the mock-up modifications are required to establish the approval of the Local Field Code Authority, the Contractor shall provide these modifications and additional follow-up field inspections as required without additional cost to the Owner.

3.02 FACTORY TESTING

A. All factory-built fan coil units shall be tested in accordance with the latest applicable industry standards as specified herein and be UL or ETL listed.

3.03 FIELD TESTING

A. Refer to Section 15990 for additional testing requirements for factory-built fan coil units.

END OF SECTION 15 ---