ADDENDUM NUMBER 3

MILWAUKEE COUNTY
WAR MEMORIAL – ART MUSEUM
HVAC IMPROVEMENTS
Site #265, Bldg. #40
750 North Lincoln Memorial Drive
Milwaukee, WI 53202

Project Number: O517-14629

Notice Number: 6978

Date of Addendum: January 13, 2015

This Addendum to the Contract Documents is issued to modify, explain or correct the original documents, dated December 5, 2014, and is hereby made part of the Contract Documents. Acknowledge receipt of this Addendum in the space provided on the Bid Form, or bid may be rejected.

BIDDING AND CONTRACT DOCUMENTS

- There will be a second meeting to provide additional information and a bidders walk through of the project (Contract 1) at the Milwaukee Art museum commencing at 10:00 AM January 16, 2015. All interested parties will meet at the War Memorial North entrance security desk. This is not a mandatory meeting for those contractors that have already attended the January 5th Pre-Bid. Contractors wishing to bid this project must attend at least one of the Pre-bid meetings set up by Milwaukee County or their bids will not be opened. As a matter of public record, all questions will be will be addressed in writing and submitted to all participating bidders.
- Johnson Controls/York is an approved vendor for air handling units.
- Delete specification section 234100 Particulate Air Filtration (1 page). Insert new complete section 234100 Particulate Air Filtration, dated 01/09/15.
- Milwaukee County will receive quotations from air handling unit equipment manufacturers for AHU-N, AHU-S, AHU-NE, AHU-SE, and AHU-EE. Bids shall include filters, coils, fans, variable frequency drives, dampers, and ancillary components as indicated on attached schedules and specifications. Price shall include delivery to site, unloading, and storage by mechanical contractor. Bids will be submitted to Milwaukee County and are due 01/16/15. Shop drawings will be submitted within five (5) days of contract award. Equipment delivery to site shall occur no later than eight (8) weeks after shop drawing approval date.

DRAWINGS

- Sheet M500, Revise the following schedules per the attached documents: Air Handling Units schedule, Air Filter schedule, Heating Coil schedule, Cooling Coil schedule, Fan schedule.
- Sheet M101A, M103A, M104A, M105A, All ductwork indicated as demolition on these plans shall be completed as Contract 2 and not part of this contract. All new ductwork on floors and in walls will be part of Contract 1. All demolition of ductwork in Sub-basement shall be Contract 1, demolition of existing air handling units on Lower Level shall be Contract 1, and demolition of existing air handling units on Lower Level shall be Contract 1.

End of Addendum No. 3

SECTION 230514
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The conditions of the Contract (General, Supplementary, and other Conditions) are hereby made a part of the Division 23 (Mechanical) and apply to all sections within this Division. If this Section is in conflict with Sections in the General Requirements, This Section shall apply.

1.2 INDEX OF SECTION 230514

A. Part 1 – General

- 1.1 Related Documents
- 1.2 Index of Section 230514
- 1.3 Related Work
- 1.4 Reference Standards
- 1.5 Submittals
- 1.6 Operating and Maintenance Data
- 1.7 Equipment Startup and Agency Training
- 1.8 Warranty

B. Part 2 – Products

- 2.1 Manufacturers
- 2.2 Design and Construction
- 2.3 Performance Requirements
- 2.4 Control Features
- 2.5 Protection Features
- 2.6 Diagnostics
- 2.7 Quality Assurance Tests
- 2.8 Bypass Equipment
- 2.9 AC Input Line Reactors
- 2.10 Output Line Filter

C. Part 3 – Execution

- 3.1 Variable Frequency Drives (VFD)

1.3 RELATED WORK

A. Section 233400 - HVAC Fans
B. Section 237313 - Modular Indoor Central-Station Air-Handling Units

1.4 REFERENCE STANDARDS

A. ANSI/IEEE 519 Guide for Harmonic Control and Reactive Compensation of Static Power Converters

1.5 SUBMITTALS

A. Include physical, electrical, and performance characteristics of each variable frequency drive and associated components, including dimensions; weight; input and output performance; voltage, phase, current and overcurrent characteristics; installation instructions; protective features; wiring and block diagrams indicating specified options; electrical noise attenuation equipment where required to meet the criteria specified; line side voltage notch wave form and line side current harmonics; certified efficiency versus load and speed curves; and required operating environment.

1.6 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section General Requirements.

1.7 EQUIPMENT STARTUP AND AGENCY TRAINING

A. Provide the services of a factory trained and certified technician to approve the installation; start-up, test, and adjust for proper operation of the unit(s). Upon completion of the equipment startup, submit a complete manufacturer's field report, including startup and test log, signed by the factory trained technician. Coordinate with the Temperature Control Contractor and the Balancing Contractor. The startup shall be coordinated with Division 26. Electrical and shall be completed within ten (10) working days from the startup date as set by the Owner.

1.8 WARRANTY

A. The warranty shall be for a period of twenty-four (24) months from the date of project Substantial Completion. Further, the warranty shall include all parts, labor, travel time, administrative costs, overhead, travel expenses, technical support and any and all other costs to provide the warranty service.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB, Toshiba, Danfoss, Trane/Danfoss, GE, Emerson, Yaskawa, Eaton/Cutler Hammer, Mitsubishi, and Allen Bradley.

B. The consultant shall identify any VFDs to be installed in plenum areas and specify plenum rated devices in those areas.

2.2 DESIGN AND CONSTRUCTION

A. The unit shall be variable torque, modular design for control of the motors, as specified in Division 23, and rated at the motor full load nameplate amps.

B. The unit shall be U.L. listed, solid state, microprocessor-based with a pulse width modulated (PWM) output wave form (none others are acceptable).

C. The VFD shall employ a full wave bridge rectifier and capacitors to minimize the ripple of the rectified voltage to maintain near constant DC voltage. Insulated gate bipolar transistors (IGBT's) shall be employed as the output switching device.

D. The VFD package shall contain the equivalent of 5% impedance to reduce harmonic distortion. The 5% equivalent impedance shall be provided in the form of a DC bus choke, an input AC line reactor in each phase, or a combination of the two methods.

E. Control circuitry shall be plug-in, plug-out modular basis with a corrosion-resistant coating on printed circuit boards.

F. Units to be suitable for an operating environment from 0°C to 40°C temperature and humidity up to 90% non-condensing.

G. Electrically and physically isolate control circuitry and conductors from power circuitry and power conductors. Control conductors and power conductors shall not be run in the same pathway.

H. The unit enclosure shall be NEMA 1, as required for the application minimum, and all components shall be fully factory assembled and tested prior to leaving the manufacturing facility.

I. A manual bypass is required on VFD installations where adequate redundancy of mechanical systems does not exist and a bypass is required to make the building functional on VFD failure. This determination should be made based on evaluating the mechanical system, what it is serving, the consequences of a failure, and economic impact on the project. There may be some cases when a manual bypass is not economical (such as in very small motor applications

J. Include the following operating and monitoring devices mounted on the front cover:

1. A disconnect switch or circuit breaker to de-energize both the drive and bypass circuit with door interlocked handle and lock-open padlocking provisions.
2. Operating mode selector switch marked "Hand-Off-Auto."
3. Manual speed adjustment via keypad, mounted on the door.
4. Manual bypass selector switch to select power through drive or bypass.

K. Provide a manual bypass circuit and bypass starter to transfer from variable frequency drive operation to bypass operation (if a bypass is provided).

2.3 PERFORMANCE REQUIREMENTS

A. Units shall be suitable for input power of electrical system, as scheduled on the drawings, ±10%, 3 phase, 60 Hertz nominal.

B. Use a current limiting control device to limit output current to 110% continuous for one (1) minute; also refer to Protection Features in this section. Full load output current available from drive shall not be less than motor nameplate amperage. The full load amp rating of the VFD shall not be less than the values indicated in NEC Table 430-150.

C. Output power shall be suitable for driving standard NEMA B design, three phase alternating current induction motors at full rated speed with capability of 6:1 turndown.

D. Additional performance capabilities to include the following:

1. Ride through a momentary power outage of 15 cycles
2. Start into a rotating load without damage to drive components or motor
3. Capable of automatic restart into a rotating load after a preset, adjustable time delay following a power outage
4. Input Power Factor: Minimum 0.95 throughout the speed range

5. Minimum Efficiency: 95% at 100% speed, 85% at 50% speed

2.4 CONTROL FEATURES

A. Use control circuits compatible with input signal from temperature control system in the automatic mode and from manual speed control in the manual mode. Vary motor speed in response to the input control signal. Include components necessary to accept the signal from the temperature control system in the form that it is sent.

B. Include the following additional control features:

1. Hand-Off-Automatic (HOA) selector switch to select local or remote start/stop and speed control.
2. Analog input, selectable 0-10v or 4-20 mA, for automatic control from the temperature control system.
3. Local speed control at the VFD .
4. Adjustable acceleration and deceleration rate so that the time period from start to full speed and from full speed to stop can be field adjusted.
5. Adjustable minimum and maximum speed settings for both automatic and manual modes of operation.
6. Manual transfer bypass circuit .
7. Field adjustment of minimum and maximum output frequency.
8. Two (2) sets of programmable form "C" contacts for remote indication of variable frequency drive condition. Note: default programming to be set for "Drive Run & Fault."
9. Illuminated display keypad.
10. External Fault indicator.
11. One (1) input for a N.O. dry contact type input for a 2-wire remote start/stop
12. One (1) input for a N.C. dry contact type input for external faults (freezestats, fire alarm, smokes, etc.). This input shall be factory wired to prevent both the VFD and bypass starter operation when external fault is present.
13. One (1) N.O. dry contact output for proving motor status. This output shall be programmed to detect belt or coupling break that would remove the load from the motor. The dry contact will open on loss of load or VFD being off.
14. PID control loop capable of VFD control from an external device connected to a VFD analog input.
15. When specified in the 230993 Sequence of Operations, provide a VFD input and output for shutoff damper control that shall operate as follows: When the fan is remotely or locally commanded to start, VFD contact shall energize the shutoff damper to open the damper. The damper position end switch shall be wired to a run permissive input on the VFD and enable the VFD to start when the damper end switch provides the damper is open. This feature shall be provided for both inverter and bypass operation.

C. The VFD controller shall convert VFD information into the existing system protocol that will be compatible with the building direct digital energy management system (EMS) supplied on the project. This output shall be through a serial interface port capable of two-way communication with the building EMS provided on this project. Final connection shall not require any additional intermediate gateway devices to provide throughput of data. The following data shall be provided at a minimum:

1. Fault condition
2. Speed
3. Amperage
4. Frequency
5. Voltage
6. Bypass status (if supplied)

2.5 PROTECTION FEATURES

A. Use electronic protection circuitry in the power circuits to provide an orderly shutdown of the drive without blowing fuses or tripping circuit breakers, and prevent component loss under the following abnormal conditions:

1. Activation of any safety device.
2. Instantaneous overcurrent and/or overvoltage of output.
3. Power line overvoltage and undervoltage protection.
4. Phase loss.
5. Single and three phase short circuiting.
6. Ground faults.
7. Control circuit malfunction.
8. Over temperature.
9. Output current over limit.

B. Provide the following additional protective features:

1. Input transient overvoltage protection up to 3000 volts per ANSI 37.90A.
2. DC bus fusing or other electronic controls which limit the rate of rise of the DC bus current and de-energizes the drive at a predetermined current level.
3. Fusing for the control circuit transformer.
4. Grounded control chassis.
5. Devices and/or control circuitry to ensure that the variable frequency drive and bypass starter are not both energized and driving motor simultaneously.

2.6 DIAGNOSTICS

A. Provide an English character display (no error codes) with indicators for the following:

1. Phase loss
2. Ground fault
3. Overcurrent
4. Overvoltage
5. Undervoltage
6. Over temperature
7. Overload
8. DC bus status

2.7 QUALITY ASSURANCE TESTS

A. Use a factory heat stress test to verify proper operation of all functions and components under full load.

B. Field performance test of variable frequency drives to determine compliance with this specification will be performed at the Owner's discretion and may include any specified feature, including operation of protective devices through a simulated fault. Contractor will pay for initial testing. Should the drive be found deficient by this testing, drive manufacturer will be required to make any and all changes necessary to bring unit(s) into compliance with the specified performance, and demonstrate this performance by retesting. Cost of changes and retest will be by this contractor.

C. Variable frequency drive manufacturer or designated representative is to perform a field test of each drive, in the presence of the Owner's representative, for the following items:

1. Provide general inspection to verify proper installation.

2. Demonstrate drive reaction to simulated power interruptions of 2 seconds and 60 seconds.

3. Demonstrate adequate protection during switching from variable frequency drive operation to bypass starter operation and back again.

2.8 BYPASS EQUIPMENT

A. Bypass Starters:

1. The bypass starters for 208 volt motors, 20 HP and less; and 480 volt motors, 40 HP and less, shall be across-the-line magnetic starter type.

2. The bypass starters for 208 volt motors, 25 HP and more; and 480 volt motors, 50 HP and more, shall be solid state reduced voltage starting type.

B. Bypass Configuration:

1. Provide one main disconnect switch or circuit breaker to de-energize both the drive and bypass circuit. Provide a drive input disconnect switch or fuse block to allow the drive to be isolated while the bypass circuit is energized. Provide one output drive contactor and one output bypass contactor. The two output contactors shall be electrically interlocked to allow only one contactor to be closed at any one time.

C. Provide motor overload protection in the bypass circuit.

D. Provide bypass equipment in a common enclosure with the VFD or, if not available, in a separate enclosure.

2.9 AC INPUT LINE REACTORS

A. When needed to comply with the requirement for 5% equivalent impedance, furnish and factory install AC input line reactors.

B. Line reactors shall be installed in each phase of the AC input side of the VFD and mounted within a common enclosure with the VFD.

C. Line reactor shall be a three phase inductor, iron core, 600V, Class H insulation, 115°C rise, copper windings with screw type terminal blocks.

2.10 OUTPUT LINE FILTER

A. Provide a three phase dV/dT output filter for any 460VAC drive with output line length of over 120 feet, or as specified.

PART 3 EXECUTION

3.1 VARIABLE FREQUENCY DRIVES (VFD)

A. Install where indicated on drawings and in accordance with approved submittals and manufacturer's published recommendations. Installation to be by the Division 26 electrical contractor.

B. Input power wiring shall be installed in a separate conduit, output power wiring shall be installed in a separate conduit, and control wiring shall be installed in a separate conduit. Do not mix input power, output power, or control wiring in a common conduit. Separate conduits for input and output power wiring shall be provided for each motor. Input and output power wiring for more than one motor shall not share a common conduit. Power wiring shall be furnished and installed by the Division 26 electrical contractor. If provided, do not mount output line filter above the drive.

C. Control signal for drive will be provided under Division 23.

D. Temperature Control Contractor will furnish and install the required temperature control wiring in metal conduit and in accordance with electrical Division 26.

END OF SECTION

SECTION 234100
PARTICULATE AIR FILTRATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The conditions of the Contract (General, Supplementary, and other Conditions) are hereby made a part of the Division 23 (Mechanical) and apply to all sections within this Division. If this Section is in conflict with Sections in the General Requirements, This Section shall apply.

1.2 INDEX OF SECTION 234100:

A. Part 1 – General

1.1 Related Documents
1.2 Index of Section 234100
1.3 Submittals
1.4 Related Work
1.5 Reference
1.6 Reference Standards
1.7 Quality Assurance
1.8 Shop Drawings
1.9 Operation and Maintenance Data
1.10 Design Criteria

B. Part 2 – Products

2.1 Manufacturers
2.2 Panel Filters
2.3 MERV 7/8 Filters
2.4 MERV 11 Filters
2.5 MERV 14/15 Filters
2.6 HEPA Filters
2.7 Activated Carbon Filters
2.8 Housings for Panel Filters
2.9 Housings for MERV 7/8 Filters
2.10 Side Access Filter Housings
2.11 Filter Holding Frames
2.12 Filter Gauges

C. Part 3 – Execution

3.1 Installation
3.2 Filter Gauges

1.3 SUBMITTALS

A. Product Data: For each type of product indicated on plans. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. LEED Submittals (if applicable):

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
3. Wiring Diagrams: For power, signal, and control wiring.
4. Operation and Maintenance Data: For each type of filter and rack to include emergency, operation, and maintenance manuals.

1.4 RELATED WORK

A. Section 237313 – Modular Indoor Central-Station Air Handling Units

1.5 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.6 REFERENCE STANDARDS

A. ASHRAE Standard 52.2
B. UL 181 – Standard for Factory-Made Air Ducts and Air Connectors
C. UL 586 – Standard for High Efficiency Particulate Air Filter Units
D. UL 900 – Standard for Air Filter Units

1.7 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.8 SHOP DRAWINGS

A. Refer to Division 1, General Conditions, and Submittals.

B. Include data concerning dimensions, materials, efficiencies, installation instructions, and appropriate identification.

C. Independent test reports verifying filter performance, test procedures, and ratings.

1.9 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section General Requirements.

1.10 DESIGN CRITERIA

A. Use UL Class 1 or Class 2 filters unless noted otherwise (Reference applicable UL standard referenced).

B. Efficiencies indicated in this section are based on ASHRAE Standard 52.2.

C. Fan motors have been selected to operate against the resistance of dirty filters as specified in this section.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. American Air Filter, Barnebey-Cheney, Cambridge, Continental, Flanders, Camil-Farr, Mine Safety Appliances, Research Products. BLC Industries or approved equal.

2.2 PANEL FILTERS

A. Use 1" (or as scheduled) thick fiberglass blanket enclosed in a cardboard frame and reinforced with a perforated metal retainer on the air leaving side. Coat media with flameproof, not-volatile adhesive.

B. Media nominal rating to be 500 FPM face velocity, 0.15 inch WG initial resistance, 0.50 inches WG recommended final resistance. Average arrestance of filter media shall be 80%.

C. Provide filter holding frame.

2.3 MERV 7/8 FILTERS

A. Use 2" thick, pleated panels, 100% synthetic, self-supported media fully bonded, and sealed in cardboard frame.

B. Media nominal rating as scheduled on plans. Average arrestance of filter media shall be per 2012 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 29, Air Cleaners for Particulate Contaminants, Table 2.

C. Furnish a side access housing or holding frame as scheduled.

D. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.4 MERV 11 FILTERS

A. Use bag type, non-supported pockets, polypropylene media with synthetic backing scrim, fully bonded, and sealed in a factory fabricated frame.

B. Media nominal rating as scheduled on plans. Average arrestance of filter media shall be per 2012 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 29, Air Cleaners for Particulate Contaminants, Table 2.

C. Furnish a side access filter housing or holding frame as scheduled. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.5 MERV 14/15 FILTERS

A. Use box type, ultra-fine microglass pleated media, water resistant, plastic or aluminum separators, fully bonded, and sealed in a factory fabricated frame. Media pleats to be self-supporting under varying airflow conditions.

B. Media nominal rating as scheduled on plans. Average arrestance of filter media shall be per 2012 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 29, Air Cleaners for Particulate Contaminants, Table 2.

C. Optional: Provide a gasket on the vertical sides to prevent leakage between cartridges.

D. Furnish a side access filter housing or holding frame as scheduled. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.6 HEPA FILTERS

A. Use box type, ultra-fine microglass pleated media, water-resistant, aluminum separators, fully bonded, and sealed in a factory fabricated metal frame. Media pleats to be self-supporting under varying airflow conditions.

B. Media nominal rating as scheduled on plans. 99.97% dioctylphthalate (DOP) efficiency filter cartridges to be listed or classified under UL 586 test standard including factory certification seal.

C. Furnish a side access housing or holding frame as scheduled. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.7 ACTIVATED CARBON FILTERS

A. Use an assembly consisting of carbon steel, stainless steel, or aluminum casing, pleated bed assembly, and trays; filter servicing trays arranged in a deep V for side servicing; and disposable panel pre-filter.

B. Media to be activated carbon, 34 lb/cu ft density, pelletized or granular, with minimum carbon tetrachloride activity of 60 percent. Assemble media in thin bed trays or pleated bed cartridges with a minimum of 1.42 cu ft of carbon per 1000 CFM nominal air flow capacity.

C. Media rating at above conditions as scheduled on plans, and 99.99% efficiency by means of a Freon leak test.

2.8 HOUSINGS FOR PANEL FILTERS

A. Manufactured by air handling unit manufacturer, filter media manufacturer, or contractor fabricated. Casing and tracks constructed of galvanized or enameled steel or aluminum. Provide access to the media tracks from outside the casing so media and be readily changed.

2.9 HOUSINGS FOR MERV 7/8 FILTERS

A. Housing or holding frame to be of the same manufacturer as filter media or provided by the air handling unit manufacturer. Contractor fabricated housings or filter racks will not be accepted. Casing and tracks constructed of galvanized or enameled steel or aluminum. Provide access to the media tracks from outside the casing so media can be readily changed. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.10 SIDE ACCESS FILTER HOUSINGS

A. Galvanized steel housing with aluminum or galvanized steel filter mounting tracks. Mounting tracks and access doors to have gaskets to minimize air bypass around the filters. Housing assembly to be suitable for use in duct systems with based on design inches of water static pressure.

B. Standard filter sections provided by air handling unit manufacturers may be used for MERV 11, MERV 14, and MERV 15 filters but will not be accepted for HEPA filters or activated carbon filters.

C. Insulate housings where adjacent duct or air handling apparatus is insulated. Insulation to be contained within a 2" thick, double wall steel panel and meet the requirements specified for adjacent duct or apparatus.

D. Furnish a door on each end of the housing to facilitate filter changing. Doors to be hinged and provided with lever handle latches to secure the door. Doors shall not be secured with nuts, bolts, wing nuts, or sheet metal screws.

E. Furnish housings for MERV 11, MERV 14, MERV 15, HEPA filters, or activated carbon filters with a lever action sealing mechanism to secure media in tracks.

F. Filter bypass shall be less than 5% of design cfm.

G. Include an integral pre-filter track for installation of MERV 7 and MERV 8 pre-filters. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.11 FILTER HOLDING FRAMES

A. Construct frames of aluminum or corrosion-resistant coated steel with provisions for assembly in a bank.

B. Frames for MERV 11 filters, MERV 14 filters, MERV 15 filters, HEPA filters, and activated carbon filters to have provisions for installation of MERV 7 and MERV 8 pre-filters upstream of high efficiency media. Secure pre-filters by means of spring clips or a spring loaded mechanism. Spring clips or latches shall be on the upstream side of the pre-filter. Provide leak-proof gaskets between pre-filter media and holding frame. Pre-filters shall be removable without removal of final filters.

2.12 FILTER GAUGES

A. Manufacturers: Dwyer, or approved equal.

B. Direct reading, 3-1/2 inch dial type, diaphragm actuated, in a metal case. Lettering shall be black figures on white background. Provide front recalibration adjustment.

C. Provide gauges with the following ranges:

Filter Type	Scale Range (inch W.G.)
Panel Filters	0.0 to 0.5
MERV 7/8	0.0 to 1.0
MERV 11	0.0 to 2.0
MERV 14/15	0.0 to 2.0
HEPA Filters	0.0 to 4.0
Activated Carbon Filters	0.0 to 2.0

D. Provide one gauge for each filter bank, suitable for flush or surface mounting. Include an air filter gauge accessory package consisting of mounting bracket, aluminum tubing, two static pressure tips, and vent valves for each gauge.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Where air handling equipment is to be used for temporary heating or ventilation of a facility, do not operate the equipment until specified filter media has been installed. Contractor shall be responsible for maintaining the cleanliness of air handling apparatus and air distribution systems during construction through regular inspection and changing of filter media throughout the construction period.

B. Where air handling apparatus is used during the construction period, install new filter media prior to start of air balancing. Additionally, deliver one new set of media to the owner prior to substantial completion.

C. Install units as shown on drawings and details according to manufacturer's instructions.

D. Reinforce filter holding frames per manufacturer's instructions.

E. Maintain necessary clearance for changing filters.

3.2 FILTER GAUGES

A. Install filter gauge static pressure tips upstream and downstream of filters. Mount gauge on outside of filter housing or filter plenum in accessible position outside of the unit housing; install tubing and gauge valves between gauge and sensor tips. Adjust and level each gauge.

END OF SECTION

SECTION 237312
AIR HANDLING UNIT COILS

PART 1 GENERAL

1.1 RELATED WORK

A. The conditions of the Contract (General, Supplementary, and other Conditions) are hereby made a part of the Division 23 (Mechanical) and apply to all sections within this Division. If this Section is in conflict with Sections in the General Requirements, This Section shall apply.

1.2 INDEX OF SECTION 237312

1.3 RELATED WORK

A. Section 237313 - Modular Indoor Central-Station Air Handling Units
B. Section 238200 - Heating and Cooling Terminal Units

1.4 REFERENCE STANDARDS

A. ARI 410 Forced Circulation Air-Cooling and Air-Heating Coils

1.5 SUBMITTALS

A. Including data concerning dimensions, capacities, flow rate, pressure drop, materials of construction, ratings, weights, and appropriate identification at the same time that the air handling equipment in which the coils will be located are submitted.

1.6 DESIGN CRITERIA

A. Select coil sizes, capacities, configuration, and operating characteristics as shown on the plans and/or as scheduled. Coil capacity ratings shall be ARI 410 certified.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Ventrol, RAE Corporation, Trane, York, Marlo, Wing or approved equal.

2.2 HOT WATER COILS

A. Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.

B. Construct coils of 0.025 inch tube wall seamless copper tubes of 5/8 inch maximum outside diameter with maximum of 8 aluminum fins per inch suitable for working pressures to 125 psig and temperatures to 250°F. Coil fins may be the continuous serpentine or plate fin type.

C. The 0.025 inch tube wall may be increased to a maximum of 0.035 inch if the agency can establish evidence of corrosive water or a history of freezing conditions. The desired maximum fins are 8 fins per inch. If more than two rows are required to meet the needed heating capacity at 8 fins per inch, then the fins may be increase up to 12 fins per inch as needed to keep the rows at two maximum.

D. Coil headers may be constructed of cast iron, steel, or seamless copper. Where cast iron headers are used, expand tubes into the headers. Where steel or copper headers are used braze tubes to header. Install a strainer upstream of the control valve serving each coil or coil bank.

E. Provide coils with bronze spring turbulators where required to provide the capacities indicated.

2.3 CHILLED WATER COILS

A. Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.

B. Construct coils of 0.025 inch tube wall seamless copper tubes of 5/8 inch maximum outside diameter with maximum of 8 aluminum fins suitable for working pressures to 200 psig. Coil fins may be the continuous serpentine or plate fin type.

C. Coil headers may be constructed of cast iron, steel, or seamless copper. Where cast iron headers are used, expand tubes into the headers. Where steel or copper headers are used braze tubes to header. Install a strainer upstream of the control valve serving each coil or coil bank.

D. Coils shall be drainable type with drain and vent plugs for each header.

PART 3 EXECUTION

3.1 HOT WATER COILS

A. Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer. Mount coils in field erected units to allow for individual removal.

B. Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.

C. Install a separate air vent and drain valve for each coil header in such a manner that the vent and drain valves are located outside of air handling unit casing. Provide offsets in piping to facilitate coil removal.

D. Unless otherwise specified, pipe coils for counter flow arrangement.

3.2 CHILLED WATER COILS

A. Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer. Mount coils in field erected units to allow individual removal.

B. Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.

C. Install a separate air vent and drain valve for each coil header in such a manner that the vent and drain valves are located outside of air handling unit casing. Provide offsets in piping to facilitate coil removal. Unless otherwise specified, pipe coils for counter flow arrangement.

D. Where coils are installed in ductwork or field erected air handling units, provide a 1-1/2" deep 18 gauge welded stainless steel drain pan as an integral part of the duct or at coil support.

E. Install condensate drain trap with proper depth from each cooling coil condensate drain to the nearest drain location.

1. Make sure there is sufficient depth below air handling unit cooling coils to obtain the proper depth of trap; spring vibration isolators or housekeeping pads will not provide sufficient height.

END OF SECTION

SECTION 237313
MODULAR INDOOR CENTRAL-STATION AIR HANDLING UNIT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The conditions of the Contract (General, Supplementary, and other Conditions) are hereby made a part of the Division 23 (Mechanical) and apply to all sections within this Division. If This Section is in conflict with Sections in the General Requirements, This Section shall apply.

1.2 INDEX OF SECTION 237313

1.3 SUMMARY

A. This section includes variable-air-volume, single-zone air handling units.

B. Substitute equipment may be submitted for consideration as a Substitute Bid with the provision that the substitute equipment shall meet or exceed the performance criteria and the equipment and components specified in This Section. Each item of performance criteria and the equipment and components shall be clearly defined in this substitute manufacturer's current printed catalog. Two (2) copies of the current printed catalog shall be submitted to the Engineer for review. Substitute Bids will be considered only when submitted in addition to the Base Bid.

C. This equipment shall have capacities, ratings, and performance capabilities, which meet or exceed the requirements specified herein and as scheduled.

D. Any auxiliary devices or appurtenances required by the manufacturer for proper installation, including safety devices, shall be provided as an integral part of the equipment Base Bid.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified, and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.

2. Cabinet material, metal thickness, finishes, insulation, and accessories.

3. Fans:

a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.
c. Fan construction and accessories.
d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.

5. Dampers, including housings, linkages, and operators.

6. Filters with performance characteristics.

7. Submit detailed wiring diagrams for power and control systems and differentiate between Manufacturer- and field-installed wiring for Contractor-provided units.

B. LEED Submittal (if applicable):

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

C. Delegated-Design Submittal: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

D. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.

2. Support location, type, and weight.

3. Field measurements.

E. Seismic Qualification Certificates: For air handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Source quality-control reports.

G. Field quality-control reports.

H. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 – "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: Two set(s) for each air-handling unit fan.

1.9 WARRANTY

A. Provide a written five (5) year extended warranty for the compressor, to be executed by the Manufacturer and signed by the contractor, which shall agree to replace components that fail in materials or workmanship within the specified warranty period, provided that the Manufacturer's written instructions for installation, operation, and maintenance have been followed.

B. The warranty period for the heat exchangers shall be the Manufacturer's standard warranty period, but not less than ten (10) years after the date of substantial completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, all air-handling units shall be manufactured by Ventrol. Other manufacturers offering similar products may be incorporated, they include and are limited to, the following:
1. Ventrol, basis of design
2. Temtrol
3. Governair
4. Mammoth
5. Huntair

2.2 MANUFACTURED UNITS

A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, dampers, plenums, filters, drip pans, mixing dampers and other accessories as indicated on drawings or schedules.

2.3 AIR HANDLING UNITS

A. General: This specification covers the performance requirements and the material/construction requirements of custom-built air handling units. The detailed performance and data sheets and/or equipment schedule drawing(s) are considered part of this specification.

B. Warranty: The manufacturer shall provide the parts warranty for equipment manufactured and all vendor supplied components. The said warranty shall cover replacement of all defective parts for a period of 12 months from equipment start up, not to exceed 18 months from date of shipment.

C. Submittal: The successful manufacturer shall provide Shop drawings and submittal data for review. The submittals and shop drawings shall be complete in all respects including the following information:

1. Overall unit dimensions and individual components and section dimensions.
2. Sound analysis consisting of inlet, outlet and radiated sound power levels per unit performed by an AMCA 300 accredited lab.
3. Shipping and operating weight of unit and/or sections.
4. Materials of construction.
5. Cross section details of typical wall, floor and roof construction.
6. Component equipment data as detailed in component specification section.
7. Unit performance data including sound data.
8. Details of coil support in a coil bank.
9. Piping connection sizes and approximate locations.
10. Door and window sizes and elevations.
11. Drain pan details.
12. Operating and Maintenance Data.

D. Product Delivery, Storage, and Handling

1. All equipment shall be delivered to the job site suitably packaged and protected for overland trucking using heavy-duty protective shrink-wrap plastic. Where multiple units are required, a schedule of priority will be furnished which shall determine the manufacturing and delivery sequence. In general, units shall be delivered in one piece unless indicated otherwise. Where building constraints, unit size or trucking limitations require that units ship in more than one piece, the manufacturer shall indicate all split points on the shop drawings. All items shipped loose such as filters, steam humidifier assemblies, caulking, etc. shall be itemized on the packing slip and be suitably secured in the unit or on a separate pallet.

E. General Design Considerations:

1. Coils shall be arranged so that space between coils is a minimum of 24", unless specifically shown otherwise on drawings. Coil assembly shall have provisions to facilitate total or partial removal from coil bank. Housing shall be designed and sealed to minimize air and water vapor leakage. Housing shall be designed and tested to meet maximum leakage of SMACNA class 3 when tested in accordance with the procedure outlined in the SMACNA HVAC Air Duct Leakage Manual.

2.4 UNIT CONSTRUCTION

A. Unit Base / Floor / Frame Work (Lobby Units Only):

1. The unit base frame is manufactured with 2" X 5" X 0.188" HSS type rectangular structural tubing and fitted with 16" on-center C-channel cross support members. Sheet metal formed unit bases are not acceptable. The "Double Bottom" base features a 4.5" thick insulated walk-on floor as specified below. The base rails are fitted with Bolted removable lifting lugs at the unit or module (if demounted) corners. Sheet metal lifting lugs are not acceptable. Floor liner shall be 16-ga, G-90 galvanized steel. Floor seams shall be sealed to create leak free joints. All seams shall be continuously welded to form a water tight assembly. The perimeter of the unit consists of a 1½" upturned perimeter lip to create a drainable floor. The under floor liner shall be 22-ga, G-90 galvanized steel and recessed nominal ½" to allow for air circulation under the unit floor. The entire unit base must be polyurethane foamed in place with a minimum thickness of 3" and a minimum R value of 20. Fiberglass insulated unit bases will not be acceptable. Maximum deflection of floor shall be L/360 at design loading (L=span in inches), the minimum floor design load is 150 lbs/sq ft (distributed load), and the maximum point load on floor shall be 300 lbs (over 1 square foot).

B. Panel structural strength:

1. Maximum deflection of walls and roof shall be L/240 at +/- 12" w.c. for 3 and 4" construction and L/180 at +/- 8" w.c. for 2" construction (L= span in inches) at unit operating pressure. Deflection is worst case at the center of panel.

   a. Minimum roof and wall load is 75 lbs /sq ft (distributed load such as wind and snow).
   b. Maximum point load on roof shall be 300 lbs (over 1 square foot).

C. Cabinet Insulation:

1. The polyurethane injected foam, 2.5 pcf with an effective thermal conductivity (C) of 0.154 BTU in/hr sq.ft°F). The foam insulation has an ozone depletion potential of 0, a global warming potential of 0 and is VOC exempt. It is also rated UL94 HF-1 according to ASTM-E84 test method.

D. Cabinet:

1. Formed and reinforced wall panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. Outside Casing shall be solid 16-ga, Bright spangled G-90 galvanized steel, double die-formed 4" thick panel secured with 1/4" hex head, zinc plated fasteners at 12" on-centers.

2. The inside liner shall be 20-ga, G-90 galvanized steel and incorporate a 5 degree bend on all exposed surfaces to eliminate any waving. Liner shall be secured with sheet metal screws to outside casing at 12" on-centers.

3. Under normal internal operating design conditions, there shall be no condensation on the unit exterior at the following ambient conditions:

   Indoor units 105°F DB, 80°F WB

E. Knocked down unit construction (Large AHU's Only)

1. Unit shall be shipped in pieces small enough to fit through the available opening(s), yet large enough to minimize work required in the field by installing contractor. Each piece or assembly of pieces shall be clearly marked and refer to a clear and concise assembly drawing. Factory personnel shall be provided to supervise the assembly from start to finish. Manufacturer shall guarantee the performance of the field assembled units just as if they were built in the factory. Approval by factory personnel shall confirm that installing contractor followed all assembly procedures and that unit will perform as specified.

2. Field assembled filter frame assemblies shall be constructed of galvanized steel and be specifically designed and sized for field assembly. Filter frames shall have matching mounting holes such that frames may be riveted together. Frame comes with pre-installed gasket so as to provide a surface onto which the filter will self seal. Filter frames come with stiffeners which are installed between each column of filter frames. Stiffeners are installed in the field. All filter holding frames must be caulked in between them to minimize bypass air through the frames. Proper structural support (every 5 frames wide, an additional structural 2" tube to reinforce is recommended) for attachment of frame assembly to existing AHU casing / building structure as well as complete safing and proper air seal - materials and installation - at and around the assembled filter rack shall be provided by contractor as needed.

F. Drain Pans (Lobby Units Only) and Cooling Coil Support Structure

1. Condensate Drain Pans are IAQ design, 18-ga., 304 stainless steel and incorporate a double slope shape to eliminate standing water. All drain pans have a "Double Bottom" attached to welded structural steel base, with a minimum of 2" of insulation under the drain pan. Drain connections are standard stainless steel 1-1/4" MPT connection. All coils are self-supported to reduce unit height to a minimum. All coils shall be mounted on raised supports above drain pan to facilitate cleaning and coil removal. Coils shall have independent removable access panels on both sides of the coil to allow for coil pull.

2.5 ACCESS DOORS AND PANELS

A. Access doors are constructed with a double wall construction and an extruded aluminum frame. The doorframe features a built-in no-through-metal high density resin barrier and a perimeter gasket. Door frames with no thermal break are not acceptable. The door gasket is seamed together at each corner to prevent leakage through the door. Door is attached to the unit with 3 axes adjustable stainless steel hinges. Doors shall open against higher pressure side. Where this is not feasible due to site constraints, an interlocking mechanism furnished on the fan section access door with a de-energizing switch.

B. Inspection access panels and doors shall be sized and located to allow periodic maintenance and inspections. Provide access panels and doors in the following locations as shown on drawings.

C. Dual-paned tempered glass (Large Units Only) with vacuum seal windows, molecular sieve sealant and thermally broken frames shall be supplied as shown on unit drawings. Singled paned windows are not acceptable.

2.6 FANWALL TECHNOLOGY

A. Manufacturers

1. CES Group, Custom Environmental Systems, including Governair, Huntair, Mammoth, Temtrol, Venmar, Ventrol, or approved equal.

    a. Must be submitted per project specifications.
    b. Must guarantee submitted AHU performance for flow, pressure, and acoustics at the perimeter boundary of the unit.
    c. Any corrective acoustical treatment, added airway tunnel lengths, increased electrical service, and any structural modifications necessary to meet specified and scheduled performance shall be provided at no additional cost to the Owner to meet the specified performance criteria.

B. Fans

1. Fans shall be aluminum airfoil, Class III, direct drive arrangement and shall be individually housed. Fans shall be certified by AMCA for performance. Fan shall be housed in a "cell." Class I and Class II fans are not acceptable.

2. Fan housing or "cell" shall be constructed of aluminum with perforated inner liner, melamine insulation, with either solid or perforated outer panels as required by application.

3. Fan/motor assembly shall be mounted within the housing on an adjustable slide rail base. Fan/motor assembly must be capable of either horizontal or vertical application.

4. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, for fan application class BV-5, to meet or exceed a rotational imbalance Grade G.55, producing a maximum rotational imbalance of .022" per second peak, filter in (.55mm per second peak, filter in). "Filter in" measurement indicates that the specified balance grade must be achieved at the submitted design operating speed for the fan(s). Fan and motor assemblies submitted for approval incorporating larger than 215T frame shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement with a maximum rotational imbalance of .022" per second peak filter in (.55 mm per second peak, filter in).

5. Fan and motor assemblies shall be designed for application in multiple fan arrays.

C. Motors

1. All motors shall be standard foot mounted type, TEAO motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere.

2. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2.

3. Motors shall be as manufactured by Baldor or Toshiba. Motors shall be available in 1/2 HP increments at nameplate HP ratings from 1.5 HP through 12 HP.

4. All motors shall include permanently sealed bearings and shaft grounding means to protect the motor bearings from electrical discharge machining due to stray shaft current. Motors provided with hybrid ceramic bearings, when specified, do not require shaft grounding devices.

5. Steel cased motors and/or ODP motors are not acceptable.

D. Acoustical Performance

1. The AHU unit shall provide the specified acoustical performance as scheduled for the unit supply discharge opening(s), RA opening(s), and the Outside air and Exhaust air opening(s).

2. Coplanar silencer(s) and/or sound attenuator(s) shall be provided to meet specified acoustical requirements. Sound attenuator cross sectional area shall be selected to not exceed 500 fpm. Losses from sound attenuating devices must be included in the fan performance selection.

3. Listed or alternate manufacturers, other than the basis of design, providing fan arrays that incorporate fans which are not manufactured by the AHU manufacturer, must provide modeled acoustical performance of the AHU unit.

4. Sound and performance data for approval showing only single fan performance for multiple fan array application will be returned without review.

5. Any proposed remedy for deviations in submitted sound power levels shall be approved by a registered acoustical consultant as selected by the owner or architect. Costs for review of proposed changes shall be borne by the contractor.

E. Multiple Fan Arrays

1. The fan array shall consist of multiple housed fans or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air tunnel cross section and components contained therein.

2. Each fan and motor assembly shall be removable through a 24" wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor.

3. All fans in the multiple fan arrays shall be AMCA certified for performance per AMCA arrangement "A" testing configuration. The submitted fan performance shall be inclusive of system effects attributed to the fan mounting arrangement, fan enclosures, back draft dampers, and other fan appurtenances not considered when AMCA certified performance per AMCA arr. "A" is determined. Submitted AHU/fan performance that does not indicate allowances for system effects for the back flow prevention device(s), wheel enclosures, safety screens, bearing pedestals, belt guards, or the fan and motor enclosure in which each fan is mounted, will be returned to the contractor disapproved and will need to be resubmitted with all of the requested information included for approval. Added system effects for acoustic attenuators, or other devices required to meet specified fan performance and sound levels must be indicated in the submitted fan selection data.

4. Fan system power requirements or sound power levels that fail to meet specified performance levels shall be corrected to meet specified performance levels at no additional cost to the owner. Any proposed corrections for power or sound deviations from specified values must be submitted to the engineer for approval prior to implementation of any proposed corrective procedure.

5. Submittals for units providing less than the scheduled quantity of fans and/or spacing of the fans for multiple fan arrays shall submit CFD modeling of the air flow profile for approval that indicates uniform velocity and flow across all internal components without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.

6. Manufacturers that do not manufacture their own fans for the specific purpose of use in multiple fan arrays, shall provide a letter guaranteeing submitted AHU performance for flow, pressure, and acoustics at the perimeter boundary of the unit signed by an officer of the OEM fan manufacturer being submitted. Any corrective acoustical treatment, added airway tunnel lengths, increased electrical service, and any structural modifications necessary to meet specified and scheduled performance shall be provided at no additional cost to the owner to meet the specified performance criteria. All proposed corrective actions, when required, must be submitted for approval and shall include a guarantee of performance, as listed above, at no additional cost to the owner.

F. Backdraft Dampers

1. Each fan applied in multiple fan applications shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan, or multiple fans, becomes disabled. The system effect for the submitted back flow prevention device shall be included in the calculation to determine the fan TSP for fan selection purposes, and shall be indicated as a separate line item SP loss in the submitted fan selection data. Manufacturers other than the basis of design being submitted must provide independent lab certification of fan testing that indicates the system effects attributed to the submitted back flow prevention device in the submitted close coupled mounting arrangement at the inlet of the fan. Fans submitted with discharge dampers will not be approved.

2. Back Draft Damper performance data that is based on an AMCA ducted inlet and ducted discharge mounting configuration will not be accepted. Submitted Back flow prevention device data must be reflective of close coupled mounting at the intake of the fan(s) per the project design documents. Motorized dampers or other motorized devices submitted for back flow prevention are not acceptable.

3. AHU Manufacturers that do not manufacture the fans being submitted must provide tested and certified performance data for fans as installed in the AHU unit including the back draft damper system effects introduced by close coupled back draft dampers at the fan inlet.

G. Fan Airflow Monitoring

1. Fans shall have noninvasive, zero pressure drop flow a/o pressure sensing taps installed in the fan inlet cone for airflow monitoring capability as specified.

H. Control Panel

1. Each fan motor shall be individually wired to a motor control panel containing motor overloads and VFD(s). VFD configuration is as follows:

   a. Single VFD with Bypass (LOBBY UNITS)
   b. Each motor having its own VFD (LARGE AHU's)

2. Each control panel shall have single point electrical power connections. Therefore, units with supply and return fan wall would have two power connections.

3. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards and local code requirements.

2.7 COILS

A. Type "WC" Chilled or Hot Water Coils

1. Primary Tube Surface

a. Round seamless 5/8" O.D. copper tubes with Optional 0.025, 0.035, and 0.049" wall thickness mechanically expanded into fin collars of the secondary surface. Tubes shall be mechanically expanded to provide a permanent metal-to-metal bond for efficient heat transfer. Manufacturer may only use staggered tubes in direction of airflow and only return bends - reduced tube wall hairpin bends are not acceptable. Ten (10) rows maximum.

2. Secondary Fin Surface

a. Die-formed, corrugated plate-type Optional 0.010" Aluminum or 0.006, 0.008, 0.010" Copper fins with full drawing fin collars to provide accurate fin spacing control and maximum tube contact. Twelve (12) fins per inch maximum.

3. Headers

a. Seamless copper with die-formed holes to provide a parallel surface to the coil tube for strong brazing joints. Coil is supplied with 1/8" brass female pipe thread (FPT) vents and drains. All circuiting is designed to gravity-drain.

4. Connections

a. Red Brass Schedule 40 male pipe thread (MPT) to prevent dielectric reaction between dissimilar metals.

5. Casing

a. Minimum 16 GA. G-90 galvanized steel with 1-1/2" die-formed flanges to permit easy stacking and mounting. Intermediate tube supports are supplied on coils over 44" fin length with additional supports every 42" multiple thereafter.

6. Testing and Performance

a. All coil assemblies are leak tested under water at 500 PSIG. Standard construction is suitable for 250 PSIG operating pressure up to 300° F. PERFORMANCE is CERTIFIED under ARI Standard 410. All coil performance ratings are generated with manufacturer's ARI certified selection software.

7. Manufacturer

a. Coils shall be Ventrol or equivalent.

2.8 FILTERS, FILTER FRAMES, AND FILTER BANKS

A. Prefilters: See filter section.

B. Final Filter: See filter section.

C. Carbon Filter: See filter section.

2.9 STEAM DISTRIBUTION SHORT ABSORPTION MANIFOLD

A. See Humidifier section.

2.10 DAMPERS

A. Low leakage aluminum dampers as made by TAMCO Model 1000. Dampers are made of extruded aluminum airfoil blades with extruded EPDM blade gaskets and extruded TPE frame seals, 7/16" aluminum hexagon shaft, aluminum linkage crank-arm, aluminum pivot pin, acetyl copolymer inner bearing and polycarbonate outer, and a 12-ga. aluminum frame.

2.11 ELECTRICAL

A. An interlocking mechanism is furnished on the fan section access door. The de-energizing switch is compliance with CAL-OSHA, ETL and the mechanical protection requirements of UL 1995.

B. Motor starter panels with main disconnect.

C. Each motor is wired to a junction box mounted on the unit exterior.

D. Each motor is wired to a non-fused disconnect (with auxiliary switch).

E. Units are equipped with an electrical cabinet unit heater.

F. Units are equipped with vapor proof light fixture(s) with guard. Unit drawing's fixture locations are approximate. Lights shall be controlled by one switch or each light will have its own switch. Refer to unit plans for details. Conduit for lights and outlets shall be electrical metallic tube (EMT). Flexible conduit connections shall be liquid tight. All junction boxes shall be gasketed.

G. Units are equipped with vapor proof light fixture(s) with fluorescent bulbs (with guard). Unit drawing's fixture locations are approximate. Lights shall be controlled by one switch or each light will have its own switch. Refer to unit plans for details. Conduit for lights and outlets shall be electrical metallic tube (EMT). Flexible conduit connections shall be liquid tight. All junction boxes shall be gasketed.

H. 120 volt G.F.I convenience outlets provided. See drawings for quantity and locations.

2.12 MOTOR WIRING

A. Motor shall be wired to NEMA-1 enclosure located on the exterior of unit fan housing. Conduit shall be appropriately sized EMT with a 3 ft. section of Greenfield flex conduit at the motor to provide a vibration loop. EMT conduit used up to 100 HP, TEK wire used on 100 HP and up, when single point wiring is required.

B. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26.

C. AHU tag must bear the ETL label.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases using restrained spring isolators. Secure units to anchor bolts installed in concrete bases. "Cast-in-Place Concrete" Section. Comply with requirements for vibration isolation devices, as required.

1. Minimum Deflection: 2 inches.

2. Install galvanized-steel plate to equally distribute weight over elastomeric pad.

3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

6. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Equipment Mounting: Install air handling unit using restrained spring isolators. Comply with requirements for vibration isolation devices, as required.

C. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices, as required.

D. Arrange installation of units to provide access space around air handling units for service and maintenance.

E. Do not operate fan system until filters, temporary or permanent, are in place. Replace temporary filters used during construction and testing, with new, clean filters.

F. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Specification Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using minimum NPS 1-1/4 pipe size, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Chilled-Water Piping: Comply with applicable requirements in "Hydronic Piping" Section. Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Refrigerant Piping: Conform to applicable requirements of Division 23. Provide shutoff valves and piping.

G. Connect duct to air-handling units with flexible connections. Comply with requirements in "Air Duct Accessories" Section.

H. Electrical: Conform to applicable requirements of Division 26 sections.

I. Ground Equipment: Tighten electrical connectors and terminals according to Manufacturer's published torque-tightening values. Where Manufacturer's torque values are not indicated, use those specified in UL-486A and UL-486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.

2. Charge refrigerant coils with refrigerant and test for leaks.

3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Automatic-Roll-Filter Operational Test: Operate filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating.

5. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.

6. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.

7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify that shipping, blocking, and bracing are removed.

3. Verify that unit is secure on mountings and supporting devices and those connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.

4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.

7. Verify that face-and-bypass dampers provide full face flow.

8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.

9. Comb coil fins for parallel orientation.

10. Verify that proper thermal-overload protection is installed for electric coils.

11. Install new, clean filters.

12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.

3. Manually operate dampers from fully closed to fully open position and record fan performance.

C. Program the units for the desired operation and communication.

D. This Contractor shall be present during startup as required.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in "Testing, Adjusting, and Balancing for HVAC" Section for air handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation testing, adjusting, and balancing air handling unit and air distribution systems, and after completing startup service, clean air handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 COMMISSIONING

A. All startup checklists and testing and balancing reports shall be submitted to the Engineer prior to scheduling Commissioning.

B. Coordinate with the factory-authorized service representative to perform commissioning service.

C. This Contractor shall be present during commissioning as required. Contractor shall allocate two (8) hour days for commissioning.

D. Verify that units are installed and connected according to the Contract Documents.

E. Commissioning shall include testing steps per scripted procedure from Engineer. Scripted steps shall be completed prior to witness testing with Engineer and Owner.

F. This Contractor shall coordinate with electrical contractor to perform verification of all wiring per scripted procedure.

3.9 DEMONSTRATION

A. A factory-authorized service representative shall train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, serving, and preventive maintenance.

2. Review data in the maintenance manuals.

3. Schedule training with Owner, through Engineer, with at least 7 days' advance notice.

3.10 AIR HANDLING UNIT SCHEDULE

A. See schedule for additional information.

END OF SECTION

AIR HANDLING UNIT (AHU)

UNIT NO.	SERVICE	UNIT ARRANGEMENT	SUPPLY FAN							MOTOR			FILTER				WEIGHT (LBS)	MANUFACTURER	MODEL	REMARKS
			TOTAL CFM	OUTSIDE AIR CFM	EXT. S. P. (IN. WC.)	TOT. S. P. (IN. WC.)	TYPE	NO.	RPM	HP	VOLT	PH	PREFILTER		FINAL FILTER					
													MERV	DEPTH (IN.)	MERV	DEPTH (IN.)				
AHU-NE	EAST ADDITION	DRAW THRU	7,000	815	2.00	4.75	FAN WALL	2	3,623	7.5	460	3	8	2	11	12	5,532	VENTROL	CUSTOM	1, 2, 3, 4, 5
AHU-SE	EAST ADDITION	DRAW THRU	7,000	815	2.00	4.75	FAN WALL	2	3,623	7.5	460	3	8	2	11	12	5,532	VENTROL	CUSTOM	1, 2, 3, 4, 5
AHU-EE	ELEC ROOM	DRAW THRU	8,500	N/A	N/A	4.0	PLUG	1	1,888	4	460	3	8	2	N/A	N/A	5,600	VENTROL	CUSTOM	4, 6

REMARKS:

1. PROVIDE AND INSTALL SUPPLY, RETURN, AND OUTSIDE AIR CONTROL DAMPERS.
2. REFER TO SUPPLY FAN, HEATING COIL, AND COOLING COIL SCHEDULES FOR ADDITIONAL REQUIREMENTS.
3. UNITS BOTH NORMALLY OPERATING, SUPPLYING AIR TO COMMON DUCT LOOP.
4. CONFIRM FILTER TYPE WITH FILTER SCHEDULE
5. PROVIDE AUTOMATIC DISCHARGE DAMPER (BACKDRAFT) AT EACH UNIT OUTLET.
6. PROVIDE MANUALLY OPERATED OPPOSED BLADE DAMPER IN RETURN DUCT FOR BALANCING.

SHEET M500
3 ADDENDUM 3
01/09/2015

AIR HANDLING UNIT SCHEDULE

AIR FILTER SCHEDULE

TAG	LOCATION	SERVICE	TYPE	SIZE (IN.)			EFFICIENCY %	INITIAL APD (IN. WC.)	FINAL APD (IN. WC.)	MANUFACTURER	MODEL	REMARKS
				W	H	D						
PF-1	AHU-N	AHU-N	PLEATED	240	96	2	MERV 8	0.21	1.0	FLANDERS	CUSTOM	1
PF-2	AHU-S	AHU-S	PLEATED	240	96	2	MERV 8	0.21	1.0	FLANDERS	CUSTOM	1
CF-1	AHU-N	AHU-N	CARBON	240	96	4	N/A	0.43	0.70	PURAFIL	CUSTOM	1
CF-2	AHU-S	AHU-S	CARBON	240	96	4	N/A	0.43	0.70	PURAFIL	CUSTOM	1
FF-1	AHU-N	AHU-N	PLEATED	252	120	12	MERV 15	0.6	1.50	FLANDERS	CUSTOM	1
FF-2	AHU-S	AHU-S	PLEATED	252	120	12	MERV 15	0.6	1.50	FLANDERS	CUSTOM	1
PF-3	AHU-NE	AHU-NE	PLEATED	72	36	2	MERV 8	0.21	1.0	FLANDERS	CUSTOM	1
PF-4	AHU-SE	AHU-SE	PLEATED	72	36	2	MERV 8	0.21	1.0	FLANDERS	CUSTOM	1
FF-3	AHU-NE	AHU-NE	PLEATED	72	36	12	MERV 8	0.21	1.50	FLANDERS	CUSTOM	1
FF-4	AHU-SE	AHU-SE	PLEATED	72	36	12	MERV 8	0.21	1.50	FLANDERS	CUSTOM	1
PF-5	AHU-EE	AHU-EE	PLEATED	72	36	2	MERV 8	0.21	1.0	FLANDERS	CUSTOM	1

REMARKS:

1. ALL FILTER SIZES AND PRESSURE DROPS SHALL BE CONFIRMED WITH SUCCESSFUL AHU PROVIDER.

AIR FILTER SCHEDULE

SHEET M500
3 ADDENDUM 3
01/09/2015

HEATING COIL SCHEDULE

TAG NO.	SERVICE	AIR SIDE								WATER SIDE				BRANCH PIPE SIZE (IN.)	STATUS	REMARKS
		AREA (SQ. FT.)	ROW	FPI	CFM	TOTAL MBH	EAT °F DB	LAT °F DB	APD ("WG)	EWT (°F)	LWT (°F)	GPM	WPD (FT. WG)			
HC-1	AHU-N	180.0	1	6	73,000	2,191.8	50.0	77.7	0.04	180.0	160.0	224.3	3.32	4	NEW	1
HC-2	AHU-S	180.0	1	6	73,000	2,191.8	50.0	77.7	0.04	180.0	160.0	224.3	3.32	4	NEW	1
HC-3	AHU-NE	15.1	2	9	7,000	463.8	54.0	115.1	0.16	190.0	150.0	26.1	5.55	2	NEW	1
HC-4	AHU-SE	15.1	2	9	7,000	463.8	54.0	115.1	0.16	190.0	150.0	26.1	5.55	2	NEW	1

REMARKS:

1. PROVIDE MODULATING CONTROL VALVES.

SHEET M500
3 ADDENDUM 3
01/09/2015

HEATING COIL SCHEDULE

COOLING COIL SCHEDULE

TAG NO.	SERVICE	AIR SIDE									WATER SIDE				BRANCH PIPE SIZE (IN.)	STATUS	REMARKS
		AREA (SQ. FT.)	ROW	FPI	CFM	TOTAL MBH	SENSIBLE MBH	EAT °F DB/ EAT °F WB	LAT °F DB/ LAT °F WB	APD ("WG)	EWT (°F)	LWT (°F)	GPM	WPD (FT. WG)			
CC-1	AHU-N	180.0	6	8	73,000	2,857.7	2,202.0	80.0/65.0	52.5/51.9	0.45	43.0	56.7	415.0	9.27	5	NEW	1
CC-2	AHU-S	180.0	6	8	73,000	2,857.7	2,202.0	80.0/65.0	52.5/51.9	0.45	43.0	56.7	415.0	9.27	5	NEW	1
CC-3	AHU-NE	14.8	4	14	7,000	184.5	140.0	74.0/62.0	55.2/51.4	0.68	42.0	55.0	33.0	7.30	2	NEW	1
CC-4	AHU-SE	14.8	4	14	7,000	184.5	140.0	74.0/62.0	55.2/51.4	0.68	42.0	55.0	33.0	7.30	2	NEW	1
CC-5	AHU-EE	14.75	4	11	8,500	418.5	212.6	85.0/75.0	62.5/61.8	0.79	50.0	59.0	210.0	4.95	3	NEW	1

REMARKS:

1. PROVIDE MODULATING CONTROL VALVES

SHEET M500
3 ADDENDUM 3
01/09/2015

COOLING COIL SCHEDULE

FAN SCHEDULE

TAG NO.	SERVES	LOCATION (ROOM #)	AIRFLOW (CFM)		E.S.P.	FAN DATA										SPEED TYPE	MFR	MODEL NO.	STATUS	REMARKS
			NORMAL	MINMUM		FAN TYPE	CLASS	FRPM	DRIVE	SOUND IN/OUT Db	BHP	HP	VOLT	HZ	PH					
AHU-N	AHU-N	LOWER LEVEL	73,000	–	6.00	FAN WALL	–	3,460	DIRECT	–	160.6	(18) – 9.0	460	60	3	VFD	VENTROL	–	NEW	1, 2
AHU-S	AHU-S	LOWER LEVEL	73,000	–	6.00	FAN WALL	–	3,460	DIRECT	–	160.6	(18) – 9.0	460	60	3	VFD	VENTROL	–	NEW	1, 2

REMARKS:

1. INSTALL UNIT IN STRICT ACCORDANCE WITH MANUFACTURER'S INSTALLATION CRITERIA.
2. FAN MOTOR SHALL BE PREMIUM EFFICIENCY AND INVERTER DUTY FOR VFD OPERATION.

SHEET M500
3 ADDENDUM 3
01/09/2015

FAN SCHEDULE